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SEVENTEENTH REPORT

(FOURTH BIENNIAL)

OF THE

STATE BOARD OF HEALTH

OF THE

STATE OF NEW HAMPSHIRE

FOR THE

TWO YEARS ENDING NOVEMBER 1, 1902.

~~5 Pl. 39~~
(C. I. 136) ~~Sec 3659.2~~

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97419

STATE OF NEW HAMPSHIRE.

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, November 1, 1902.

To His Excellency the Governor and the Honorable Council:

I have the honor to present herewith the seventeenth report of the State Board of Health.

Respectfully submitted.

Irving A. Watson

Secretary.

GENERAL REPORT.

This report is intended to comprise the leading features of the work accomplished by the State Board of Health during the past biennial period, so far as the same may be properly presented in a legislative document.

The first portion of the report, paged in Roman numerals, is little more than a synopsis of some subjects that have received more consideration and required far more labor than could be here exhibited.

The second part of the report, paged in Arabic numerals, represents more fully and completely the large amount of labor that has been expended at the State Laboratory of Hygiene, both in the chemical and the bacteriological departments. An especially complete report is given for the period on water analysis and the water supplies of cities and towns.

A report is also made upon the effort to establish the normal chlorine lines of the state; a consideration of lead poison, and other analytical investigations. A *résumé* of the bacteriological investigations in suspected cases of tuberculosis, diphtheria, typhoid fever, and malaria is also given, together with a few papers and reports upon special subjects.

In the amount of original investigations represented, this report exceeds any heretofore issued.

Vital Statistics.

The general healthfulness of a state or country is determined very largely through its vital statistics, and but for such figures it would be impossible to know the result of sanitary work, or whether the average length of life were increasing or diminishing.

Fortunately we have an excellent registration system, and are, therefore, able to present statistics of a most reliable character. In the census year 1900 there were but four states in the Union whose registration of deaths was considered to be as accurate as, if not more accurate than could be obtained by the census department itself, these being New Hampshire, Massachusetts, Rhode Island, and Connecticut. In these states the returns were accepted by the government, and the usual census questions relating to mortality were withdrawn from the enumerators.

The population of New Hampshire, according to the census of 1900, was 411,588; in 1901 (calculated), 415,238.

The number of births, marriages, divorces, and deaths for the two years named is shown in the following table:

Vital Statistics for 1900 and 1901.

New Hampshire.	1900.	1901.	Increase.	Decrease.
Births	8,435	8,164	.....	271
Marriages	3,983	4,001	18	.....
Divorces	426	482	56	.....
Deaths	7,624	6,975	.....	649

The proportion of births, marriages, divorces, and deaths to each one thousand of the population for the two years referred to was as follows:

For the year 1900, the birth rate was 20.49; marriage rate, 9.67 (couples); divorce rate, 1.03; death rate, 18.52.

For the year 1901, the birth rate was 19.66; marriage rate, 9.63 (couples); divorce rate, 1.16; death rate, 16.79.

It will be seen that there was a marked diminution in 1901 in the number of deaths for that year from the number reported for 1900. The death rate for the year 1901 was, with the single exception of the year 1898, lower than ever before recorded.

Deaths from Certain Specified Causes.

The number of deaths from the so-called contagious and infectious diseases varies from year to year, sometimes to a marked extent, from a variety of causes, some of which appear not to be yet revealed beyond question; hence different theories regarding their prevalence are held by different writers.

The number of deaths from communicable diseases may be regarded to a great extent as indicative of the healthfulness of a locality, and of the efficiency of local health authorities in restricting and preventing this class of diseases. Many of these diseases are known to be almost completely within the control of sanitary law, while the spread of others seems to be as yet unrestrained, or only slightly controlled. There would also seem to be certain climatic influences, as yet little understood, to which may be attributed an excessive prevalence of and mortality from certain diseases, as, for instance, pneumonia, bronchitis, and influenza. It will be noted in the table that the death rate from these three diseases was much greater in 1900 than in 1901. This increased mortality from the diseases named extended over an area of the country far beyond the confines of our own state. The following table gives the mortality from this class of diseases for the years 1900 and 1901:

Deaths from Certain Specified Causes.

DISEASES.	1900	1901	Increase.	Decrease.
Pneumonia	942	716	.....	226
Tuberculosis (Consumption)	650	629	.....	21
Cholera infantum	462	368	.....	94
Diphtheria	64	60	.....	4
Croup	36	30	.....	6
Typhoid fever	100	89	.....	11
Influenza	183	139	.....	44
Scarlet fever	27	50	*23	.....
Whooping cough	40	20	.....	20
Measles	19	4	.....	15
Smallpox	.....	5	5	.....
Mumps	.....	1	1	.....
Total	2,523	2,111	.....	412

*The heavy mortality of 1901 was due to an extensive epidemic of scarlet fever in the city of Keene, with 21 deaths.

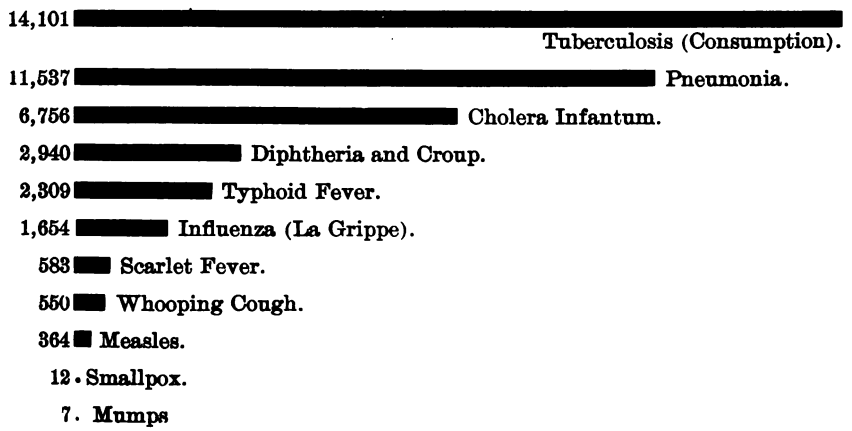
In order to know the status of a given disease as a cause of death it is necessary to study its mortality for a period of years. This is equally true of given localities, and of the entire state.

The registration reports for the past eighteen years give sufficient data for that purpose—in fact, the statistics have been so tabulated that the number of deaths from any given disease may be ascertained by town, if necessary, as it sometimes is, for guidance in sanitary work.

The foregoing table shows that for the two years 1900 and 1901 pneumonia stood first as a cause of death; but in considering this subject for a series of years it will be seen that this position belongs to tuberculosis.

Inserted herewith is a diagram which vividly illustrates the relative position of the diseases named, together with the total mortality of each for eighteen years, 1884-1901, inclusive:

Deaths in New Hampshire, 1884-1901, Eighteen Years, from Certain Specified Causes.



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diminution in the number of deaths from tuberculosis. The annual average number of deaths from this cause from 1884 to 1901, inclusive, was 783 and a fraction.

Herewith is inserted a table showing the number of deaths from tuberculosis in its various forms from 1884 to 1901, inclusive.* The second table gives the number of deaths from tuberculosis by age periods. Its most noticeable feature is the large number of deaths in persons in the prime of life.

Mortality from Tuberculosis in New Hampshire from 1884 to 1901, inclusive.

YEARS.	Pulmonary phthisis (consumption.)	Tubercular meningitis.	Hydrocephalus.	Tabes mesenterica.	Scrofula.	Total.	Total mortality for state, all causes.	Percentages of deaths from tuberculosis to total mortality.
1884	868	*	27	4	26	925	6,194	14.93
1885	857	*	25	2	22	906	6,201	14.61
1886	809	19	23	11	16	878	6,426	13.66
1887	766	16	23	7	16	828	6,479	12.78
1888	742	13	30	14	21	820	6,854	11.96
1889	651	24	21	13	22	731	6,696	10.91
1890	825	30	13	6	15	889	7,368	12.07
1891	695	15	22	19	11	762	7,310	10.42
1892	736	24	16	10	17	803	7,988	10.05
1893	737	27	23	21	14	822	7,663	10.72
1894	714	22	22	21	10	789	6,898	11.43
1895	693	20	23	21	7	764	6,929	11.02
1896	679	25	21	15	15	755	6,791	11.11
1897	697	15	17	2	12	743	7,027	10.57
1898	607	24	10	7	12	660	6,743	9.78
1899	582	21	14	13	7	637	7,045	9.04
1900	650	31	10	9	8	708	7,624	9.28
1901	629	25	1	4	12	681	6,975	9.76
Grand total	12,937	351	341	209	263	14,101	125,211	11.26
Annual average	.....	.....	.....	.....	.....	783+	.....	.....

* Not classed separately.

The State Board of Health has, from time to time, published a large number of papers, circulars, etc., on the restriction and prevention of tuberculosis, and it realizes that this work must be continued, and that it must be supplemented by every means within the power of the state if the mortality from this disease is to be materially reduced from its present proportions.

* This, as well as the following table, was prepared by the secretary of the board for the report of the Commission on State Sanatorium for Consumptives, being herewith inserted for record purposes and for the information of those who may not have access to the report mentioned.

Deaths from Tuberculosis by Age Periods.

YEARS.	1 to 10.	10 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	Over 80.	Not stated.
1884	50	113	218	145	93	78	64	67	21	19
1885	49	98	219	161	109	75	75	43	19	9
1886	44	87	233	152	94	67	71	37	18	6
1887	34	88	193	145	101	78	55	46	21	5
1888	48	88	219	137	71	62	55	42	15	5
1889	36	81	147	120	77	56	65	53	10	6
1890	49	77	200	156	113	65	72	63	23	7
1891	47	87	174	131	89	67	57	43	10	10
1892	28	88	178	150	84	67	71	41	20	9
1893	45	71	204	139	92	65	64	34	14	9
1894	50	70	200	150	82	59	45	45	8	5
1895	31	66	210	129	85	60	49	51	10	2
1896	41	81	180	130	85	59	49	37	9	8
1897	36	79	225	143	70	46	49	32	12	5
1898	26	53	181	143	66	52	47	22	7	10
1899	26	57	169	103	80	65	38	28	10	6
1900	36	70	193	120	76	45	61	44	1	4
1901	42	57	178	130	71	53	48	40	7	3
Total	718	1,411	3,521	2,484	1,538	1,119	1,015	768	235	128

During the period under consideration (1884-1901) there died in New Hampshire, from all causes, between the ages of twenty and thirty, 8,646 persons, of whom 3,521 succumbed to tuberculosis; or, in other words, 40.72 per cent, or 1 to 2½ decedents, were caused by tuberculosis.

Between thirty and forty years of age there were from all causes 7,916 deaths, and from tuberculosis in the same age period 2,484, a percentage of 31.38, or one to every three and a fraction deaths.

Between forty and fifty there was a total of 7,915 deaths from all causes, 1,538 of which were credited to tuberculosis, equal to 19.43 per cent, or one in every five deaths.

If we make our calculations on the entire period, twenty to fifty years, we find that 30.81 per cent, or one death in every three and a fraction, was due to tuberculosis.

INFLUENZA.

Influenza is one of the communicable diseases that has come into noticeable prominence in this country during the past ten years. The first wave of the epidemic touched this state in 1890, when thirty-three deaths were returned from it. In the following year there were one hundred and forty-three deaths, and in 1892, three hundred and thirty-one, which represents the crest of the wave. In 1893, ninety-one deaths were returned; in 1894, one hundred and twenty-one; in 1895, one hundred and twenty-one; in 1896, forty-seven; in 1897, one hundred and thirty;

in 1898, fifty-one; in 1899, one hundred and seventy; in 1900, one hundred and eighty-three,—the highest number since 1892; and in 1901, one hundred and thirty-nine.

It will be seen that as a cause of death, influenza has during the past ten years exceeded scarlet fever, typhoid fever, diphtheria, and croup.

With respect to age, the decedents from influenza are chiefly past middle life, and, like pneumonia, it is especially fatal to the aged. The same precautions should be taken against it is are to pneumonia: protection against sudden changes, care of sputum, and, as far as practicable, isolation of the patient.

Diphtheria and Croup.

For the year 1901 there were returned sixty deaths from diphtheria and thirty from croup, the smallest number reported in the past twenty years. For the year 1900 there were reported sixty-four deaths from diphtheria and thirty-six from croup, which, with a single exception, is lower than the record for either of the preceding registration years. To what extent the work done at the State Laboratory of Hygiene in the matter of diagnosis, and the consequent early isolation of cases, and the use of antitoxin may have contributed to this result is problematical, but it is fair to assume that one of these measures has had a restrictive influence, while the other has been curative beyond question.

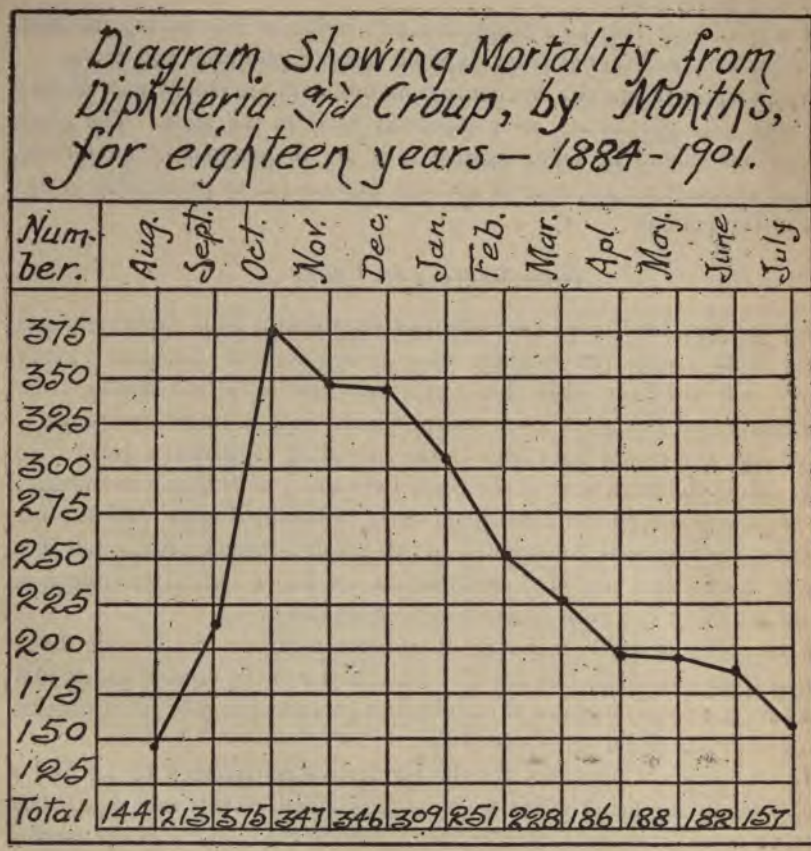
From 1884 to 1901, inclusive, there were returned to the state 2,940 deaths from diphtheria and croup. An analysis of the records shows that these are practically diseases of childhood, a great majority of the decedents being children under ten years of age.

In studying the mortality for the eighteen years referred to, we find a confirmation of a belief which we have entertained, to wit: that diphtheria prevails more extensively immediately following the opening of the schools in autumn. The diagram on next page is a graphic illustration of this assertion.

That diphtheria is frequently spread in the school-room by pupils infected but showing only slight local trouble, or none at all, is a matter of observation and record. There are many ways in which this disease may be communicated from pupil to pupil in the school-room,—indeed, while this is being written we are in receipt of a report from a city in another state giving an account of the spread of diphtheria by the common use of lead pencils, which were collected every night and distributed to the pupils in the morning without being disinfected. The use of a common drinking cup is another source of infection.

With all the sources of infection, many of which are not recognized by the people generally, it is gratifying that the mortality from diphtheria

and membranous croup has been reduced to much smaller proportions than formerly.



In August, at the end of the vacation season, diphtheria is at its lowest ebb. Schools commence in September, and the disease takes an upward start, reaching its highest point in October.

Typhoid Fever.

During the past twenty years the mortality from typhoid fever has only four times fallen below one hundred. In 1895 there were ninety-nine deaths from it; in 1897, ninety-two; in 1899, ninety-two; and in 1901, eighty-nine, the number for the latter year being the smallest ever reported.

The diminution in the prevalence, as well as in the mortality, of typhoid fever in recent years is attributed to improved sanitary conditions, and, more particularly, to the substitution of public water supplies from uncon-

taminated sources for the surface wells that have so often proved dangerous to families and communities. It has been remarked that the character of the water supply of a city or state could be determined, approximately, by a study of the mortality returns from typhoid fever, as this is chiefly a water-borne disease. It is conceded that the bacillus of typhoid fever is taken into the system through foods or drinks. Infected milk has in some instances been the means of spreading the disease in a given community. Occasionally it appears where its source cannot be traced. Like some other diseases, it is sometimes spread by a "walking" case, or by a person who has become convalescent but whose system still carries the germs. It is pre-eminently a disease due to unsanitary conditions, and the absence of the old-time epidemics is due to the progress that has been made in recent years in sanitation.

Scarlet Fever.

For the year 1900 there were returned twenty-seven deaths from scarlet fever, and for 1901, fifty deaths, the latter being a larger mortality than has occurred from this disease in several years prior to 1901. The excess over the average for the past ten years was due to the extensive epidemic in Keene, which resulted in twenty-one deaths in that city. Its prevalence there was owing to the spread of the infection among the operatives of a factory, by whom it was distributed over almost the entire city—all due to the fact that the first case or cases were not reported to the board of health, and therefore were not isolated. This sad experience graphically illustrates what might have been prevented by isolation of the first case.

The largest number of deaths from this disease occurred in children between one and five years of age; the next group of greatest mortality were between five and ten years of age.

This is essentially a disease of infancy and childhood, the mortality from it after the fifteenth year being very low. There is occasionally a death from scarlet fever in an adult, but rarely. The disease is spread very largely through the mild, unrecognized cases that go about, and even attend school while in the stage of desquamation.

Smallpox.

In the last report of this board it was stated that smallpox made its appearance in Manchester in August, 1900, the first case in the state since April, 1895. A review was given of the outbreak which occurred from that date to the following November, it having invaded Manchester, Pittsfield, Chichester, Danbury, Hooksett, and Portsmouth.

During the two years embraced in the peroid from November 1, 1900, to November 1, 1902, there were reported to the State Board of Health 634 cases of smallpox, including varioloid, from thirty towns and cities in New Hampshire. The following table gives the localities, number of cases, and number of deaths reported:

Smallpox in New Hampshire from November 1, 1900, to November 1, 1902.

Cities and Towns.	Number of cases.	Number of deaths.
Alstead	1	
Auburn	5	
Bartlett	4	
Berlin	127	2
Bethlehem	7	
Concord	2	1
Exeter	1	
Franklin	5	
Goffstown	1	
Grantham	8	1
Hampstead	1	
Hancock	5	
Harrisville	41	
Hillsborough	4	
Hudson	4	
Jaffrey	1	
Keene	5	
Lisbon	12	2
Manchester	249	
Milford	18	*1
Nashua	76	1
Newfields	1	1
Newport	1	
Northfield	3	
Portsmouth	2	
Rochester	7	
Somersworth	17	1
Tilton	16	
Troy	1	1
Warren	6	
Whitefield	5	1
Total	636	12

* Died from pneumonia following smallpox.

During only short periods in the last two years has the state been free from smallpox. The first outbreak, and a great majority of those succeeding, was due to the importation of the disease from outside the state. It has been confined almost wholly to the French population, and has been due to a lack of vaccination. Its prevalence in this state, as well as throughout the entire country, has been largely due to the mild type of the disease, which has resulted in unrecognized cases, and in some instances in a mistaken diagnosis. In addition to this some cases have been kept from the knowledge of the health authorities until more or less persons were exposed to the infection. All this has rendered it very difficult for the health officers to suppress the disease promptly.

To meet this condition, the State Board of Health, at a meeting held December 29, 1900, adopted the following regulations, in addition to the

rules and regulations then in force, to be in effect after January 1, 1901, in such towns and cities as it might be deemed wise or necessary to promulgate the order:

REGULATION RELATING TO SMALLPOX AND OTHER ERUPTIVE DISEASES.

Whenever any eruptive disease, showing papules, pustules, vesicles, etc., or any breaking out of the skin, or any condition resembling measles, scarlet fever, chicken-pox, or smallpox, shall appear upon any person (member of a family, boarder, roomer, or visitor), the head of the family, or some member thereof, shall, within twenty-four hours after the discovery of such eruption, report each and every case to the board of health, unless said case or cases are attended by a physician.

Any person violating any of the provisions of this regulation shall be punished by a fine of ten dollars and costs for each offense, in accordance with section 1, chapter 108 of the Public Statutes.

The foregoing regulation shall be in force until otherwise ordered.

Attest:

IRVING A. WATSON,
Secretary.

The foregoing order was printed in French, as follows:

REGLEMENT RELATIF A LA PETITE VEROLE ET AUTRES MALADIES ERUPTIVES.

Toutes les fois qu'une maladie éruptive, montrant des papules, des pustules, des vésicules, etc., ou toute autre irruption de la peau ou quelque condition ressemblant à la rougeole, à la fièvre scarlatine, à la picotte volante, ou à la petite verole paraîtra sur n'importe quelle personne (membre d'une famille, pensionnaire, logeur, ou visiteur), le chef de famille, ou quelques uns de ces membres, devra dans les vingt-quatre heures après la découverte de cette irruption, reporter chaque cas et tous les cas au Conseil d'Hygiène, à moins que ce ou ces cas soient soignés par un médecin.

Toute personne violant quelque provisions de ce réglement será puni d'un amende de dix piastres et les frais pour chaque offense, d'accord avec la section 1, chapitre 108 des Statuts Publics.

La règle ci-dessus sera en force jusqu'à ce qu'il en soit ordonné autrement.

Attesté:

IRVING A. WATSON,
Secrétaire.

Copies of this order, in English and French, in towns and cities where it was put in force, were distributed from house to house, and resulted in some instances in the prompt report of cases to the local health authorities. Some arrests were made for violation of this order and fines imposed.

In some instances it has been necessary for the State Board of Health to assist the local authorities in the suppression of smallpox by sending an inspector to the locality to work in co-operation with the local board

of health. This service has been of great assistance to the local authorities, and has been fully appreciated by them.

In some cases the lack of a well-organized health department with sufficient means and the necessary assistants to cope with an outbreak of smallpox has made it necessary for the State Board of Health to assist in the executive management of the disease, while in all the outbreaks the advice of the board, at least, has been sought.

The board has labored under considerable difficulty in securing experienced inspectors, and has been obliged to depend upon the chance of getting some health officer whose duties would admit of his leaving his own jurisdiction. A permanent inspector would have relieved the board of some annoyances and would have enabled it to offer greater and more continuous aid to local authorities.

DIFFICULTIES IN DIAGNOSIS.

In a great majority of the outbreaks of smallpox the State Board of Health has been obliged to furnish a medical expert to determine positively the nature of the disease. The fact that for many years smallpox has so rarely appeared in New Hampshire that a great majority of the practicing physicians have never seen a case, has caused them to feel unqualified to make a positive diagnosis in cases of so mild a type, especially in atypical forms of the disease. In every case where application for a medical expert has been made the board has complied with the request, although the diagnosing of disease is not one of the duties ordinarily devolving upon a state or local board of health. The exceptional and peculiar circumstances in connection with this particular disease have not only caused the board to feel justified in pursuing this course, but that it was a duty.

THE QUESTION OF VACCINATION.

The presence of so large a number of cases of smallpox in the state during the past two years, to wit, 634 cases, has emphasized in the most positive manner the value of vaccination as a protection against smallpox, inasmuch as in not one of these cases, so far as we are able to learn, was the person well vaccinated. Nearly all the cases were in persons who had never been vaccinated, although in a few instances persons who had been vaccinated many years previously and not recently re-vaccinated contracted varioloid.

Now and then a person has become infected who considered that he was protected against smallpox because the operation of vaccination had been performed, resulting in a sore due to non-aseptic conditions at the time the operation was performed, or to subsequent infection of the

wound by external means, such as the finger-nails in scratching the wound (which frequently occurs in children), soiled clothing, etc., without vaccinia.

We have frequently seen the disease in a family in which a portion of the children were vaccinated and the remainder unvaccinated, and in no instance have we known the former to contract the disease, although they were exposed under conditions most favorable for infection.

The question of vaccination does not admit of any discussion on its merits, and no reference to it would be made except for the purpose of counteracting the baseless and absurd statements that are made against vaccination by certain persons, and to assure the public that successful vaccination is the only known preventive of smallpox.

The legislature of 1901 amended section 2 of chapter 93 of the Public Statutes, relating to the vaccination of school children, so as to read as follows:

SECT. 2. No child shall attend any public, parochial, or private school unless he has been vaccinated or has had the smallpox, and this section shall be enforced by the board of health.

Every board of health in the state has been notified of the provisions of the section referred to, and asked to enforce the law to the letter. In most of the towns of the state this has been done. Some towns and cities have made provision for the free vaccination of such persons as were not able to bear the expense themselves. Such provisions may be made by boards of selectmen under the provisions of section 1, chapter 110 of the Public Statutes. In many localities certificates of vaccination are required of children entering school. A card for that purpose is furnished by the State Board of Health to physicians, upon request, as follows:

THE STATE OF NEW HAMPSHIRE.

CERTIFICATE OF VACCINATION.

This certifies that I vaccinated (whether successfully or not to be hereafter determined) .....on the .....day of .....190 .

.....M. D.

Examined.....190 , and found result to have been successful.

.....M. D.

This certificate shall be considered as worthless after two weeks from the date of vaccination unless the second certificate is made by some physician stating that the vaccination was successful.

The experience of health authorities throughout the entire country, in dealing with the epidemic of smallpox which has prevailed for the past two or three years, has shown that vaccination has by no means received the consideration due it as a surgical operation at the hands of many

practitioners of medicine; that special attention is not always given to the technique of the operation necessary to insure proper and successful vaccination.

At a meeting of the Conference of State and Provincial Boards of Health of North America, held at New Haven, Conn., in November, 1902, a special committee on vaccination presented the following report, which was unanimously adopted:

1. That vaccination may be defined as follows: an inoculation by scarification, puncture, or injection beneath the epidermis of a vaccine which produces, with some constitutional disturbance, the typical vaccine vesicle, which leaves, after the pock has healed, its characteristic scar.

2. That in order to obtain the most satisfactory results, vaccine must be produced either by federal, state, or provincial officials, or by private producers under the closest supervision of qualified government officials.

3. That for the greatest protection against smallpox, state and provincial laws should provide machinery whereby certified public vaccinators must be appointed for the systematic vaccination, by house to house visitation, of all children born during any year, and at public stations or otherwise of such others as circumstances may make necessary.

4. That the evidence of successful vaccination of all school children naturally forms a part of any system of public vaccination, and certificates of such should be accepted only when signed by municipal or local health officer.

5. That in order that the best results may be obtained, it is essential that medical colleges should be urged to provide for thorough instruction in the theory and practice of vaccination, and that all licensed physicians must hold certificates of having had practical instruction in the operation of vaccination in medical colleges, dispensaries, or public vaccine stations.

Recent Legislation.

The legislature of 1901 passed some enactments relating to public health matters which are herewith given.

Section 3 of chapter 110 of the Public Statutes, relating to smallpox and pestilential diseases, was amended so as to read as follows:

Sect. 3. It shall be the duty of every physician who attends upon any person infected with the smallpox, the malignant cholera, diphtheria, scarlet fever, or other malignant pestilential disease, immediately to report the same to the health officer, or, in their absence, to the selectmen of the town. If any physician shall neglect so to do, he shall be fined one hundred dollars, or be imprisoned not exceeding ninety days, or both.

To strengthen the hands of local boards of health in the prevention of some of the communicable diseases, the following was enacted:

An Act to provide for the Restriction of Communicable Diseases.

Section 1. A physician called upon to attend a sick person, and who finds the cause of such sickness to be of a contagious or infectious character, and

the general public likely to be endangered thereby, may quarantine such person's residence at once and report the fact to the board of health. Such quarantine shall continue in force until relieved or revoked by the board of health.

SECT. 2. Whenever any person knows or has reason to believe that any member of his family or household (boarder, roomer, or visitor) has either smallpox, diphtheria, membranous croup, scarlet fever, typhoid fever, measles, or any other malignant communicable disease, he shall, within twenty-four hours, if no physician is in attendance, give notice thereof to the local board of health of the town or city in which he resides, and such notice shall be given either verbally to one of the health officers, or by communication addressed to the board of health, and duly mailed within the time specified.

SECT. 3. The board of health, upon being notified of the existence of either of the four diseases first named in section 2, or of other malignant pestilential disease, shall immediately quarantine the infected house, premises, or rooms, so as effectually to isolate the case, and the family if necessary, in such a manner as will prevent the spread of the disease.

SECT. 4. Whenever a house, tenement, or room is placed in quarantine, a placard shall be posted in a conspicuous position, giving the name of the disease and also containing the following quarantine order: "All persons are strictly forbidden to enter or leave these premises without special permit from the board of health. All persons are strictly forbidden to remove this card without orders from the board of health."

SECT. 5. Upon the appearance of either of the diseases named in section 2 in any town or city in the state, the board of health shall make an immediate report to the State Board of Health upon blanks furnished for that purpose, and shall thereafter make a weekly report as long as the disease continues, stating number of cases, number of infected houses, fatality, and such other facts as may be required by the State Board of Health.

SECT. 6. At a proper time, after the convalescence or death of the infected person or persons, the board of health shall cause the infected premises to be thoroughly disinfected and cleansed, so as effectually to destroy all contagion, said work to be carried out according to mehods indorsed and recommended by the State Board of Health, after which the said premises may be released from quarantine.

SECT. 7. No parent, guardian, person, or persons having the custody of any child shall permit such child, if infected with any communicable disease, or has been exposed to such, to attend any public or private school.

SECT. 8. It shall be the duty of a health officer, or a representative of a local board of health, to attend a meeting of a State Board of Health, when requested by the latter, for consultation in the restriction and prevention of contagious and infectious diseases, or for the consideration of other important sanitary matters.

SECT. 9. Any person who knowingly violates any provision of this chapter, or any regulation established by authority of this chapter, shall be punished by a fine of ten dollars for each offense.

SECT. 10. All acts and parts of acts inconsistent with this act are hereby repealed, and this act shall take effect upon its passage.

[Approved February 20, 1901.]

The above act has been printed upon all placards used by local boards of health in quarantining premises infected with diphtheria, membranous croup, scarlet fever, etc. The chief features of the measure are:

First. A physician may establish a quarantine.

Second. Families are obliged to report certain communicable diseases if no physician is in attendance.

Third. Local boards of health shall make weekly reports to the State Board of Health.

Fourth. Disinfection shall be performed by local boards of health.

Fifth. No child infected with any communicable disease shall be allowed to attend school.

Legislation relating to the adulteration of milk, legal standards, etc., is embraced in the following two sections from an act in amendment of chapter 107 of the Public Statutes, 1901:

AN ACT IN AMENDMENT OF CHAPTER 127 OF THE PUBLIC STATUTES, RELATING TO THE INSPECTION OF MILK. . . .

SECT. 17. If any person shall adulterate milk, skim-milk, or cream with water or otherwise to be sold, or shall sell or offer for sale, or have in possession with intent to sell, any adulterated or unwholsome milk, skim-milk, or cream, containing any coloring matter or preservative, or any milk produced from sick or diseased cows, or cows fed upon the refuse of breweries or distilleries, or any other substance which may be deleterious to the quality of milk, skim-milk, or cream, or shall sell, or offer for sale, or have in possession with intent to sell as pure milk, any milk from which the cream or a part thereof has been removed, he shall be fined not more than two hundred dollars, or imprisoned not more than sixty days, or both. And it shall be the duty of boards of health and milk inspectors to file the necessary information with the chief of police of the city or town or the county solicitor of the county in which such city or town may be situated, and it shall be the duty of such chief of police and county solicitor to prosecute offenders under this act to final judgment and sentence.

SECT. 18. In all proceedings under this chapter, if the milk is shown, upon analysis, to contain less than 13 per cent of milk solids, or to contain less than 9½ per cent of milk solids exclusive of fat, or to contain less than 3½ per cent of fat it shall be considered evidence of adulteration except during the months of April, May, June, July, August, and September, when milk containing less than 12 per cent of milk solids, or less than 3 per cent of fat, shall be considered evidence of adulteration, or if, in the case of skim-milk, it shall contain more than 91 per cent of water and less than 9 per cent of milk solds exclusive of fat, it shall be considered evidence of adulteration.

The law relating to the sale of poisons was amended so as to restrict the amount of arsenic that may be legally used in the manufacture of certain fabrics, as follows:

AN ACT IN AMENDMENT OF CHAPTER 269 OF THE PUBLIC STATUTES, RELATING TO THE SALE OF POISONS.

SECTION 1. Chapter 269 of the Public Statutes is hereby amended by adding thereto another section, as follows:

"SECT. 16. Any corporation, person, firm, or agent who shall sell or offer for sale or exchange any woven fabric or paper containing arsenic in any form, or any article of dress or of household use composed wholly or in part of such woven fabric or paper, or any article of dress containing arsenic, shall, upon conviction thereof, be fined not exceeding one hundred dollars; *provided, however*, that this section shall not apply to dress goods or articles of dress containing not more than one one-hundredth grain, nor to other material containing not more than one tenth grain of arsenic per square yard of the material."

In the matter of the protection of public water supplies, special legislation has been enacted from time to time to prevent the pollution of certain brooks, rivers, and ponds by manufacturing industries, sawmills, etc. The last legislature extended such protection to Ammonoosuc river, so far as wood-working establishments are concerned, in the following act:

AN ACT TO PROTECT THE AMMONOOSUC RIVER IN CARROLL, BETHLEHEM, LITTLETON, LISBON, AND BATH, AND ITS TRIBUTARIES, FROM POLLUTION BY SAWDUST AND OTHER WASTE.

SECTION 1. No person or corporation shall put or place, or cause or allow to be put or placed, any sawdust, shavings, edgings, chips, bark, or other waste, from wood-work establishments, into Ammonoosuc river, or its tributaries, in the towns of Carroll, Bethlehem, Littleton, Franconia, Lisbon, and Bath. Any person or corporation violating the provisions of this act shall be punished by a fine of not exceeding one hundred dollars for each offense.

SECT. 2. This act shall take effect August 1, 1904.

STATE LABORATORY OF HYGIENE.

The most important measure passed by the legislature of 1901, relating to public health interests of the state, was that creating a state laboratory of hygiene. Evidence of the truth of this assertion may be found elsewhere in this report, in a review of the extensive work done in the examination of public and private water supplies, the inspection and examination of food products, the bacteriological examinations in the investigation of suspected cases of tuberculosis, diphtheria, typhoid fever, malaria, besides work of a lesser magnitude not covered by the report.

We can certainly point with pride to what has been accomplished along these lines in the short time in which the laboratory has had an existence, and we believe it to be an invaluable adjunct to the public health service of the state, the results of its work being much more far-reaching than can

be exhibited in any report, and that it is an institution that merits and will receive at the hands of the legislature all the aid necessary for its support.

Owing to the great demand upon the laboratory for the analysis of suspected water supplies, it has not been possible to prosecute so active a work in the examination of food supplies, drugs, dairy products, etc., as was desirable, or as is contemplated in the near future. Work in the line of water analysis, particularly of those public supplies already examined, will probably not be so great in future, and therefore much more time will be given to the investigation of adulterated food supplies, drugs, dairy products, etc., as is authorized and provided for in chapter 269 of the Public Statutes.

The law creating a state laboratory of hygiene may be found on page 149 of this volume, in connection with a somewhat extensive report of the work accomplished.

Local Boards of Health.

As we have had occasion to remark in former reports, the law enacted a few years ago, making local boards of health practically continuous, in that only one new member is appointed each year, has resulted in making these organizations much more efficient than formerly, and, furthermore, each year seems to show an added executive capability in their work.

We have in the state today many excellent boards of health, posted as to their duties and taking an interest in their work. We have seen this well exemplified in many of the smallpox outbreaks, as well as on other occasions.

It is true, however, that there is occasionally (very rarely) a board composed of men apparently unsuited for the work, whose performance of their duties is perfunctory, and whose knowledge of the obligations and functions of a board of health is comparatively limited.

Formerly it was quite generally the practice for local boards of health to issue a long set of rules and regulations which, when approved by the board of selectmen of the town, recorded, and posted, were supposed to be equivalent to law. While many of these regulations were good, some were absurd and in direct violation of existing law, yet if they could not be legally enforced they were at least of a limited educational value to the community. In more recent years laws to regulate most of the ordinary conditions in themselves nuisances, or likely to become so, have been enacted, so that it has become practically unnecessary for local boards of health to issue rules and regulations.

Moreover, authority has been given the State Board of Health to make such rules and regulations for the protection of public health as it may

deem necessary, hence local boards rely upon the state board to issue such regulations as may be necessary to meet local exigencies not directly specified in chapter 108 of the Public Statutes.

Again, local boards of health feel at liberty to, and do most frequently, consult the state board in special cases and act upon the advice given.

It is by a combination of these conditions and an apparently increased interest on the part of health officers that much more efficient sanitary work is now being accomplished than was possible only a few years since.

School of Instruction for Health Officers and Sanitary Conference.

The State Board of Health, in connection with the New Hampshire Association of Boards of Health, held a "school of instruction" for health officers at the state house April 29, 30, and May 1, 1902. The program for the meeting was arranged by the State Board of Health, and consisted of eight sessions, at which valuable papers relating to public health work were read, followed by discussions of the subject.

The following papers were presented:

"Smallpox Quarantine," by George Cook, M. D., inspector State Board of Health.

"Practical Disinfection," by Lemuel Pope, Jr., D. V. M., president board of health, Portsmouth.

"Disinfection and Disinfectants," by C. E. Congdon, M. D., president board of health, Nashua.

"Quarantine and Disinfection in Contagious Diseases," by Mr. William B. Blake, inspector board of health, Manchester.

"Practical Disinfection," by Mr. Charles E. Palmer, health officer, Concord.

"How Can We Best Protect the Public from Consumption?" by Daniel S. Adams, M. D., president New Hampshire Medical Society, Manchester.

"Sanatoria and Hospitals for Consumptives," by H. T. Fontaine, M. D., Concord.

"The Contagiousness of Tuberculosis," by C. A. Weaver, M. D., chairman board of health, New Boston.

"The Struggle against Consumption," by Edward O. Otis, M. D., Boston, Mass.

"Difficulties that Confront a Country Board of Health, with Suggestions regarding Same," by Mr. G. F. Lowe, secretary board of health, New Ipswich.

"The Model Health Officer and His Duties," by D. M. Currier, M. D., president New Hampshire Association of Boards of Health, Newport.

Discussion.

"Powers of Boards of Health, Statutory and Otherwise," by John C. Bickford, Esq., president board of health, Manchester.

"A Septic Tank Designed for a Small Village," by E. H. Hunter, C. E., chief assistant to Dartmouth College engineer, Hanover.

Discussion.

"Construction of Village Sewers," by Robert Fletcher, Ph. D., director of Thayer School of Civil Engineering, Dartmouth College, associate American Society Civil Engineers, member New Hampshire State Board of Health.

"The Inspection and Control of Foods and Drugs with Reference to Their Adulteration," by Albert E. Leach, S. B., analyst to the Massachusetts State Board of Health, Boston.

"A Study of New Hampshire Water Supplies," by H. E. Barnard, B. S., chemist New Hampshire Laboratory of Hygiene, Concord.

Discussion.

"Some Data concerning the Proposed Chlorine Map of New Hampshire," by same author.

"Lead Poisoning as Related to Water Supplies," by H. E. Barnard, B. S., chemist New Hampshire State Laboratory of Hygiene.

Discussion.

"Milk Inspection," by Mr. William K. Robbins, chemist and clerk board of health, Manchester.

"Local Boards of Health and the Law," by Irving A. Watson, M. D., secretary State Board of Health, Concord.

"Diphtheria and the Klebs-Loeffler Bacillus," by D. E. Sullivan, M. D., Concord.

Discussion.

"The Bacteriology of Our Most Common Diseases," by Prof. H. N. Kingsford, M. D., bacteriologist State Laboratory of Hygiene, Dartmouth Medical College, Hanover.

"Some Bacteriological Methods of Interest to Boards of Health," by Arthur K. Day, M. D., bacteriologist State Laboratory of Hygiene, Concord.

This meeting was attended by representatives of the boards of health in over one hundred fifty towns of the state, including some of the smallest and most remote municipalities. It was admitted by all that this meeting was a source of a great deal of information to most of the health officers present, and that it would result in better work and methods in their own particular localities. That this is true has already been evidenced in numerous instances. We believe that an annual "school of instruction" of this kind would be of great value to the sanitary interests of the state.

The Sanitary Bulletin.

The Sanitary Bulletin has been published quarterly during the past two years, and is a direct means of announcing rules and regulations issued from time to time by the State Board of Health, giving information concerning the law covering special conditions, the duties of local boards of health in certain cases, papers on the restriction and prevention of disease, and many things of sanitary interest to the public generally. The Bulletin has been the means of diffusing a great deal of information in its particular line among the people of the state, and many expressions of commendation have been received for it. It will also be used as a means of informing the public of the work done from time to time in the State Laboratory of Hygiene, and particularly will it devote some consideration in the future to the question of adulterated foods, drugs, etc., as well as to some advertised preparations which, if not dangerous to the public health or misrepresented as to quality, are commercial frauds, to say the least. As stated elsewhere, a large amount of work devoted to the investigation of the water supplies of the state during the past two years has made it impossible to take up the food question as we would have done; but this subject will be given much more attention and investigation in the near future than it has ever before received in this state, and the Bulletin will be the means of communicating the results to the public.

Registration of Vital Statistics.

The board has charge of the registration of births, marriages, divorces, and deaths for the state, and makes a biennial report, mostly of a statistical nature, on the results obtained by the tabulation of these returns.

The report for the years 1900 and 1901, issued almost simultaneously with this report, consists of a volume of a little more than four hundred pages. This work does not possess much interest to the public generally, but is of incalculable value as a matter of record, and for the sanitary guidance of health authorities in showing the general prevalence of disease and the mortality of every town and city in the state, thereby becoming an index of the results of public health work, as well as pointing out localities where special work may be necessary to restrict a disease where the mortality is in excess of the general average.

In this work practically Dr. Farr's system of the classification of the causes of death is used, as it has been for many years. It has, however, become antiquated by reason of medical and sanitary advancement, and will not hereafter be used in the New Hampshire Registration Reports. The Bertillon classification, otherwise known as the "International Classification of the Causes of Death," which has been adopted by all the

Americas and a large part of Europe, will be used. It is the same classification as was used by the United States Census in its last statistical compilation of the causes of mortality.

The Commission on State Sanatorium for Consumptives.

The commission appointed by the governor, under an act of the last legislature, to consider the feasibility of establishing a state sanatorium for consumptives have not been idle, and they will present a report which will be likely to carry conviction to the minds of all who will study it from an unprejudiced standpoint.

The mortality resulting from tuberculosis in the state of New Hampshire will be shown for a period embracing the last twenty years; the number of deaths yearly chargeable to it; the age periods most largely affected; the nature of the disease itself; its curability; the results that have been attained in various sanatoria; and many other facts necessary in order to arrive at a correct conclusion.

The commission visited and carefully examined into the details of several sanatoria established for the cure of this disease. They believe that if the legislature and the public could visit these institutions all skepticism as to their value and the results accomplished would be irresistibly swept aside, and that such interest would be awakened that ample provision would willingly be made for a sanatorium in this state.

At the Massachusetts Sanatorium, at Rutland, the commission found, upon the day of their inspection, 246 patients, nearly all of whom presented an appearance of good health, with faces reddened and bronzed by constant exposure to fresh air, sunlight, and winds. Their demeanor was cheerful and happy. To cap the climax of deception, the commission witnessed a game of baseball which would have done credit to a professional team, while there was an enthusiastic audience of some two hundred persons,—yet every one of them was a consumptive.

Some of them were already recovered and were ready to be discharged, while the great majority were well along on the road to restored health.

A few years ago no one would have believed such results possible, and today, even, they seem incredible to many,—yet the facts are apparent year in and year out to those who visit these institutions.

The commission also visited the Adirondack Cottage Sanitarium, an institution begun nineteen years ago with a single small, unpretentious cottage costing eight hundred dollars, but now comprising many buildings and more than half a million dollars invested,—and all this in the name of charity, through the splendid and unselfish efforts of Dr. Edward D. Trudeau.

There the same results were apparent as were found at the Massachu-

setts institution. The annual reports show that from 50 to 70 per cent of the patients who have been there for treatment have been returned to their homes restored to health and usefulness. Nor are these the figures of temporary results, for the institution, year after year, keeps in touch with its "graduates," in order that the ultimate results of the treatment may be definitely known.

At Sharon, Mass., is another sanatorium for the treatment of consumptive females; another great work for charity's sake, established and maintained largely through the efforts of Dr. Vincent Y. Bowditch of Boston, who is recognized as an authority on this subject by the medical profession.

At that institution were found girls from the factory, clerks, school teachers, in fact young women from the various walks of life, most of whom were being rapidly restored to health. The curative results at this institution, covering its eleven years of existence, are on a par with those already mentioned.

The remarkable results obtained at these institutions place the sanatorium treatment of consumption far in advance of any other method. Indeed, in a great majority of cases it probably offers the only path to recovery.

All these facts are now matters of record. The method of treatment has been demonstrated through years of experience in this country and abroad, and it is believed that the time has come when the state should make some suitable provision whereby may be saved the lives of many who, without such opportunity for treatment, are doomed to an early death.

Commissioners of Lunacy.

The State Board of Health constitutes the State Board of Commissioners of Lunacy. The ninth report of that board, for the two years ending September 30, 1902, shows that there were, on October 1 of the present year, at the New Hampshire State Hospital and the several county almshouse institutions, 736 insane persons,—a slight decrease during the last three years.

Of the number committed to the New Hampshire State Hospital for remedial treatment by order of the board, for the two years ending September 30, 1902, 34.92 per cent have been discharged cured; 13.49 per cent, improved; 8.73 per cent, unimproved; 5.55 per cent, deceased; while the remainder are still receiving treatment.

The law was put in operation in 1889, since which time 704 persons have received treatment by order of the board.

On the subject of the criminal insane, the report says:

"The practice of committing insane criminals to the New Hampshire State Hospital, to be placed in buildings and wards occupied by other patients, is a procedure which we believe to be wrong from every point of view, and we would urge upon the legislature some action to remedy this evil. A separate building, at least, should be provided for such insane persons as have committed homicide or other serious crimes, and such building should be safeguarded against the escape of its inmates. At the present time, under the administration of existing laws, this cannot be done, and it is not an unknown occurrence for a patient who has committed murder to escape from the New Hampshire State Hospital. This institution was not designed for the reception of criminals. To obtain the best possible results it is necessary that the insane shall have the greatest possible liberty consistent with safety to themselves and others, and in no sense is the State Hospital a proper place for the incarceration of criminals."

Special Reports.

In the following pages will be found reports on the "Examination of Water Supplies," "Water Supplies of Cities and Towns," "State Laboratory of Hygiene," and "Miscellaneous Papers." Numerous sub-topics are taken up under the several heads, particularly under the last topic mentioned.

Several papers relating to specific diseases and causes of diseases are given following the special report on the laboratory work. These are so complete in themselves that a summary is unnecessary.

Reference to all of the more prominent matters contained in this report may be found in the Index.

EXAMINATION OF WATER SUPPLIES.

EXAMINATION OF WATER SUPPLIES.

Prior to the establishment of the Laboratory of Hygiene, no systematic examination of the public and private water supplies of the state had ever been attempted. It was the custom of the State Board of Health to have samples from suspected supplies analyzed by private chemists whenever it was deemed necessary, but no special attention could be given to the work; however, some of the results so obtained were published by the board from time to time. There had also been considerable work accomplished by private owners in the way of examination and analyses of projected supplies, and in cases where an outbreak of sickness suggested an impure water. The State Experiment Station had made water analyses for some years past, and reached gratifying results in the examination of the supplies of several of our larger cities. These examinations, together with suggestions and explanations concerning the work, are in part incorporated in Bulletin No. 53, entitled, "The Farm Water Supply." With the establishment of the Laboratory of Hygiene, under the management of the State Board of Health, opportunity was afforded for taking up the much-needed work in a systematic way. The results of the investigations since the opening of the laboratory are included in this report.

Since it was evident that the public supplies were furnishing acceptable water, attention has been given chiefly to the examination of private supplies suspected of causing illness and so located as to be liable to pollution. For the collection of these samples we are indebted to the physicians of the state and to the local boards of health, who have not only collected and shipped us samples, but at our suggestion closed many supplies which were shown to be unfit for drinking.

The water supplies of our state can be variously classified, but for our present purpose it is most convenient to discuss them under the heads of spring, well, and surface waters. In the class of spring waters we include those supplies which flow continuously or intermittently from the ground, or from fissured rock; well waters are those which are reached by an excavation either by digging or boring a cylindrical hole into the subsoil or stratum underlying the surface of the ground, the interstices of which are filled with water; surface waters include rivers, ponds, and lakes, either natural water courses which carry away the accumulated

rainfall or basins which store the water that drains from the surrounding watershed.

Spring waters have always been held in high repute as sources of domestic supply, and justly so, for springs as a rule yield water of a high degree of organic purity. Their water is derived from the rain which, falling upon the ground in a relatively pure condition, passes readily into the pervious soil. Soaking slowly through the soil, it reaches an impervious stratum along which it may flow for miles, losing by oxidation and filtration whatever organic matter it may have accumulated before it passed into the soil, and finally emerging at some rock fissure or gravel bed, clear and sweet, and as nearly pure water as nature furnishes. The amount of water yielded by springs depends upon the amount of rainfall absorbed by the collecting surface, and is therefore proportional to the area of such surfaces. The character of the water depends upon the nature of the materials with which it comes in contact in its underground flow. If, for example, it passes through beds of gypsum, it will contain much sulfate of lime; if over beds of iron ore, it will be chalybeate in nature. In a word, its mineral characteristics will be that of the stratum through which it passes. The granitic character of our soil and the varied topography of our landscapes insure us abundant springs, flowing pure and acceptable water.

Springs can often be utilized in supplying families and small communities with water. When it is not possible to convey the supply by gravity, the flow is frequently sufficient to work a ram, turbine, or other form of pumping engine.

The wide and favorable reputation of New Hampshire water is due to the unexcelled character and large number of spring supplies. Removed as they usually are from all danger of contamination, they furnish us thousands of supplies of unrivaled purity. Unfortunately, the natural character of the water is frequently influenced by the kind of pipe through which it is conveyed. The customary use of lead pipe for this purpose in many cases changes a pure and wholesome water to one charged with insidious poison which slowly, but none the less surely, undermines the health of the consumer. The subject of lead poisoning is treated at length in another article.

Our surface waters are also very generally pure. The waters of our three large lakes, Winnipesaukee, Sunapee, and Newfound, are as pure as any in the world. Their watersheds are so sparsely populated, and their tributaries so free from the waste of manufacturing operations, that they are magnificent natural reservoirs capable of furnishing the supply of a metropolis. Brook, pond, and river waters are generally rain waters which collect from the surface of a natural watershed, but the

character of the water as it falls in rain is much modified when it reaches its ultimate goal in pond or river. In its flow over the surface of the ground, down steep hillsides, through forests, over beds of accumulated peat, over cultivated fields and rocky wastes, it has been busy extracting material of all kinds: organic matter from the dead leaves of the forests, coloring matter from the peat and grasses of the lowlands, waste matter from the cultivated fields, mineral constituents from the rocks. As it flows on it receives the overflow of springs, drainage from inhabited areas, surface wash from pastures, sawdust and other waste matter from manufactories.

Because of their secluded location, the cleanliness of their watersheds, and the unlimited amount of water they provide, ponds and streams are usually looked to as sources of water supplies by our cities and large towns. Their water is soft and well aërated, but apt to be flat from the small amount of carbonic acid it contains. The water of ponds is also liable to be affected by the growth of fresh-water sponges and the class of plants called algæ. The former by their decay may give the water a disagreeable appearance and odor, but this is not proved injurious to health. The latter are so fine that they cannot be distinguished in a glass of water, but in larger quantities they impart a greenish hue, and the use of water so affected may cause intestinal disturbances.

As a rule, the rivers used as supplies in New Hampshire are free from sewage and so are not considered as liable to cause diseases among users of the waters. But it is a fact that in several instances our towns are using water from streams which receive sewage in greater or less quantities in the course of their flow. It has long been thought that running water would purify itself; that any sewage flowing into a river would be destroyed by oxidation in the course of twenty miles' flow, and chemical analyses have tended to support this assertion. For instance, the river Seine, which receives the sewage of Paris, becomes, fifty-five miles below the city, almost as pure as it was before the entrance of the sewage. Several factors are concerned in this apparent purification. Oxidation does occur to some extent. The experiments of the English Rivers Commission indicate that in flowing twenty miles from 20 to 30 per cent of sewage might, in summer, be destroyed by oxidation. Then precipitation is constantly going on, and suspended matter is rapidly removed by this means. But most of the apparent purification of running streams results from the great dilution of the sewage by the constant increase in the volume of a river, from both tributary streams and inflowing ground water. In this way the poisonous matters may be so diluted that they are beyond the power of chemical analysis to detect. Yet should the germs of disease have been present they are

still there, and as powerful for evil as ever. Dr. Frankland, a high authority on this subject, says: "There is no process practicable on a large scale by which sewage can be removed from water once so contaminated, and therefore I am of the opinion that water which has once been contaminated by sewage is thenceforth unsuitable for domestic use."

"If a stream has received much filth in its course, its waters should be considered objectionable, and to be avoided for human use, unless, indeed, the volume should be so great compared with the filth pollution as to be practically independent of such reasoning. If sewage contains the germs of disease, whatever they may be, no agent at present known, except a sufficiently high temperature, will efficiently destroy them." (Mass. S. B. H. Report, Vol. VIII, page 283.)

It is altogether feasible to provide against the direct contamination of water supplies from sewage by requiring all communities to treat their sewage in such manner that the effluents shall conform to a given standard of hygiene before it is permitted to go into our water courses, lakes, and ponds. From a moral standpoint they should feel obliged to render innocuous their sewage before allowing it to escape into the streams which furnish water supplies for their neighbors down the stream. The time is not far distant when legislation will compel such action and insure the continued purity of our water courses. Now that the effectiveness of the septic tank treatment has been demonstrated, no new sewage system should be introduced in the state without providing for septic treatment of the sewage, and as rapidly as possible the existing systems should be improved to conform to modern ideas.

While our villages and cities rely on surface water supplies, the great majority of our agricultural population, comprising more than 35 per cent of the inhabitants of the state, are dependent on the well for a water supply. A well, whether bored, dug, or driven, is simply a cylindrical shaft extending down into the subsoil or stratum underlying the surface. When a pervious subsoil of sand, gravel, or limestone overlies an impervious material, such as clay or granite, a portion of every rainfall enters the subsoil and, being held up by the impervious layer below, tends to accumulate. The water thus held in the interstices of the rocks lying immediately beneath the soil is "subsoil" or "ground" water, and constitutes about 40 per cent of the soil which it occupies. Its surface is not level but slopes towards its natural drainage outlet, from two to eight feet to the mile. The water thus forms a subterranean river, always flowing in one direction. A well penetrating the stratum through which this river flows is filled by the water to the same height that it occupies in the soil. If the water in the well is wholly undisturbed there will be a constant but imperceptible current in it in the direction of the

flow of the ground water, and there will be no flow into the well save in one direction. But if the well is freely drawn upon so the level of the water is below that of the water in the surrounding earth, inflow will take place from all directions. This inflow is liable to take place from a distance of one hundred feet laterally, and from a much greater distance in the direction from which the ground water flows. Hence we may accept it as a fact that filth within one hundred feet of a well will influence the character of the water. But this is not the whole truth, for the original source of filth may be much further away and have gradually defiled the soil in the direction of the well until it extended within its influence. Cesspool filth has been known to permeate through the soil for a distance of two hundred yards and poison wells.

It is wholly probable that there are 50,000 wells now in use in this state, and that 150,000 people are dependent upon them for their water supply. It is doubtless true that at one time nearly every one of these wells furnished an acceptable supply for drinking and domestic purposes. Such, however, is not the case today.

In early times little regard was given to hygienic laws, and the well was located as near the kitchen and barnyard as water could be found. The slight amount of filth which was spread upon the ground in the vicinity of the well was not sufficient to materially affect the quality of the water at first, and the fame of the pure supply was one of the legacies handed down to later generations. The well may still be used, its water may be clear and sparkling and the fame of its purity possess the minds of users of the supply; and yet the sewage of years has been poured upon the ground about the well until the water is but a pool of filth, reeking with corruption and disease.

As an example of the disease-producing properties of a bad well water, the following instance is cited: In September, 1901, a convention was held in a hall in Jaffrey and dinner was served to those in attendance. About two weeks after the convention cases of typhoid fever began to develop among those who were there. Eleven cases in all were reported, with one death. Investigation showed that the water used at the dinner was of very bad quality, and after a searching examination was held to be the cause of the epidemic. The results of the examination of the supplies which furnished the water are given under Nos. 206, 207, and 208.

In a small rural village the supply of water from wells may have been of unexceptionable quality for an indefinite time, but the place grows, population becomes more dense, the ground water is drawn upon in excess of the supply, the drainage area of the well is increased, and the water becomes less pure both from this cause and from the increased amount of sewage returned to the soil, which is sure to become saturated beyond

its power of oxidation, and pollution of wells is inevitable. Wells should be abandoned as a source of water supply for household use whenever there are more than two houses to an acre of land.

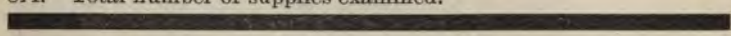
Fortunately for the health of the community, the introduction of water systems has caused many of our town and most of our city wells to be filled up. Many city wells have been examined at the State Laboratory of Hygiene, and in almost every case found grossly polluted. A few years ago the city of Brooklyn caused the water from private wells within the city limits to be examined, and of the 655 supplies but seven were found to be suitable for drinking. It is unfortunate that many men guard the honor of their water supply as sacredly as the honor of their name, and refuse to believe that a water that has been used for generations can be otherwise than pure. However praiseworthy this attitude may seem it is wholly wrong, and the time will come when sickness will teach what sanitary science has failed to do.

During the past year we have examined the water from over 800 supplies. Generally the samples have been sent us after correspondence concerning them, and in receptacles furnished by the laboratory. In some few instances, however, we have received samples in jugs and bottles of all kinds, and in such condition that an analysis of any value whatever was impossible.

From the results obtained since the establishment of the laboratory, we have prepared the following tables and diagrams, which show most clearly the general character of our waters:

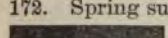
Diagram No. 1.—Showing total number of water supplies examined, and the sources from which they were derived.

814. Total number of supplies examined.



524. Well supplies.

172. Spring supplies.



81. Pond supplies.

50. Stream supplies.

Diagram No. 2.—Showing results of examinations of water supplies.

814. Total number of supplies examined.

401. Good.

321. Bad.

92. Doubtful.

413. Bad and doubtful considered in one class.

Diagram No. 3.—Showing results of examinations of well supplies.

524. Total number of well supplies examined.

180. Good.

265. Bad.

79. Doubtful.

Diagram No. 4.—Showing results of examinations of spring supplies.

172. Total number of spring supplies examined.

103. Good.

45. Bad.

24. Doubtful.

148. Total number of good supplies, ignoring the presence of lead.

Diagram No. 5.—Showing results of examinations of pond supplies.

81. Total number of pond supplies examined.

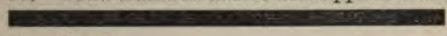
68. Good.

7. Bad.

6. Doubtful.

Diagram No. 6.—Showing results of examinations of stream supplies.

50. Total number of stream supplies examined.



45. Good.

3. Bad.

2. Doubtful.

Of the waters from the 814 supplies examined, 401, or 49.2 per cent, were of such quality as to be above suspicion, and were reported as good; 321, or 39.4 per cent were without doubt polluted and unfit to drink; and 92, or 11.4 per cent, were neither good enough to be included in the first class, nor polluted to such an extent as to make them wholly unfit for use. This last class, which we will call doubtful, includes waters that have received pollution in the past but at present are not being contaminated, or, if so, by only small quantities of filtered sewage.

To make the comparison more clearly seen, and since sooner or later the doubtful waters will become polluted, let us consider but two classes of water, good and bad. Then of the 814 waters we find 401, or 49.2 per cent, good, and 413, or 50.8 per cent, bad.

We have made another classification based on the sources of these waters, and considered them as surface, spring, well, and cistern waters; and since the surface waters received were of two classes we have further subdivided this source into pond and stream waters. Eighty-one pond waters were examined and 68, or 84 per cent, were found to be potable, or, in other words, of good quality for drinking purposes; 7, or 9 per cent, were bad; and 6, or 7 per cent, were doubtful. It is true that several of the waters classed as good contained an excess of vegetable matter during a portion of the summer, but this condition is only temporary, and usually produces no ill effect. Of the 7 waters classed as bad, three were so placed because they contained lead which was dissolved from the lead service pipes.

Of 50 stream supplies, 45, or 90 per cent, were of good quality; 3, or 6 per cent, were doubtful; and 2, or 4 per cent, were bad.

Of 172 spring sources, 103, or 60 per cent, were good; 45, or 26.5 per cent, bad; and 24, or 13.5 per cent, doubtful. These figures hardly express the sanitary condition of our springs, for 34 of the 45 bad supplies, and 11 of the 24 doubtful waters were naturally very pure, but contained lead in considerable quantities, and were necessarily reported as bad. If we ignore the effect of the lead, or, better, consider the condition of the water at its source, we find that of the 172 spring waters examined, 148, or 86 per cent, were potable.

Seven cistern supplies were examined and 5, or 71 per cent, were found to be good, although in several instances having a marked odor and disagreeable taste. Two, or 29 per cent, were bad.

But it is the well supplies that are of greatest importance, and the figures obtained are almost startling as we realize their significance. Of 524 well supplies examined, but 180, or 34.3 per cent, were good; 265, or 50.7 per cent, were bad; and 79, or 15 per cent, were doubtful. Or considering the doubtful and bad in one class, we find 65.7 per cent of the well waters bad or of questionable quality, and but 34.3 per cent above suspicion.

These figures show plainly the condition of our drinking waters.

With the facts now clearly before us, let us discuss the factors which may impair the quality of a water. Concisely stated, they are as follows:

First. The presence of substances which have a direct disturbing influence on the system. A particular instance is recognized in the use of hard waters by those who have been accustomed to soft, and *vice versa.* Many very hard waters containing iron cause dyspepsia; other naturally pure supplies are filled with lead, and so become very dangerous to the user; waters containing sulfates of magnesia and soda have a decided effect on the system. Dissolved vegetable matter in large amounts is credited with having an injurious effect, while bad odors and tastes, irrespective of their nature and origin, may be injurious to persons of delicate constitutions.

Second. The presence of the products of decay. It is well known that decaying animal and vegetable matter is unfit for food. In the process of decay, more particularly of animal matter, virulent poisons, or toxines, are often formed. It is possible that in grossly polluted waters the changes going on may produce some of these poisonous compounds.

Third. The presence of micro-organisms in the water. It has long been known that the waste products of human life are the most harmful of all forms of pollution. In seeking a cause for this harmful effect, we find the most ready explanation in the presence of the germs of disease. The numberless instances of the contamination of water by typhoid germs are abundant proof that we have our greatest enemy to healthful water in micro-organisms.

Since we now realize that under present conditions a great number of our water supplies are a constant menace to the public health, it becomes necessary to provide remedies which will avert the danger.

This problem is a hard one to work out, for it necessitates the abandonment of very many wells whose waters are polluted beyond all possibility of purification, and thus compelling search for a new supply. In some instances the expenditure of a few dollars will bring pure supplies to the

house by gravity, but in many other cases, in settlements of half a dozen families, or even less, the most advisable plan is the establishment of a common supply. The water can be raised from a spring, driven well, or stream to a standpipe or water tower, either by gravity or by a windmill, or other power, and thence piped to each householder. In this way the cost of establishing the system is reduced to a minimum for each person benefited, and a constant, safe, and wholesome supply is afforded.

In other cases where the water is but slightly contaminated, and where the cause is traceable to adjacent sink drains, cesspools, and privy vaults, the removal of these polluting influences will frequently restore the water to its normal condition.

In all cases wells should be so made that the entrance of surface water and drainage is impossible. This is best effected by bricking up the sides of the well for a distance of several feet below the surface. The bricks should be laid in cement, and thickly plastered both inside and out until impervious to water. Large earthen-ware pipes are obtainable, which, when carefully joined together by cement, afford perfect protection against the dreaded surface water.

Where danger is feared from lead poisoning, the only remedy is the substitution of the lead supply-pipe by some other approved pipe. Galvanized iron pipe will prove satisfactory in most cases. There is but little fear of zinc poisoning from its use.

METHODS EMPLOYED IN THE EXAMINATION OF WATER SUPPLIES.

We have been guided in our work by the valuable experience of the Massachusetts State Board of Health, whose investigations along the lines of pure water supplies have become classical. For the suggestions and advice they have so cordially given we express our sincere appreciation.

Since we have been obliged to rely upon the co-operation of untrained assistance in the collection of water samples, a bottle securely packed, together with full instructions for collecting and shipping, is sent to each person who requests the examination of a supply. A one-gallon bottle of clear, white glass, with mushroom stopper, is used. It is shipped in a strong wooden box, lined one inch thick with felt and left uncovered at the top. The stopper of the bottle projects above the top of the box, and thus insures the carriage of the sample in an upright position and prevents breakage through being covered by other articles. The package is marked "Laboratory of Hygiene, Concord, N. H.," and is well adapted to its purpose. There is no breakage of bottles, no freezing in winter, and the package is transported economically and without delay.

A tagged envelope, marked "Open for Instructions," is attached to the package and incloses a blank form with instructions and questions to be answered by the collector, a piece of cloth, sealing wax, and string for sealing the bottle securely and a return envelope addressed to the Laboratory of Hygiene. In this envelope the filled-out blank is placed. The instructions given and questions asked are as follows:

THE STATE OF NEW HAMPSHIRE,

STATE BOARD OF HEALTH, LABORATORY OF HYGIENE,

CONCORD, N. H.

WATER FOR ANALYSIS.—INSTRUCTIONS.

Read carefully and comply with the requirements in every particular.

1. FROM A WATER TAP.—The water should run freely from the tap for a few minutes before it is collected. The bottle is then to be placed directly under the tap, and rinsed out with water at least twice, pouring out the water completely each time. It is then again to be placed under the tap and filled to overflowing, and then a small quantity poured out, so that there shall be left an air space under the stopper of about an inch. The stopper must be rinsed off with flowing water and inserted into the bottle while still wet, and secured by tying over it a clean piece of cotton cloth. The ends of string must be sealed on top of the stopper. *Under no circumstances must the inside of the neck of the bottle or the stem of the stopper be touched by the hand or wiped with a cloth.*

2. FROM A STREAM, POND, OR RESERVOIR.—The bottle and stopper should be rinsed with the water, if this can be done without stirring up the sediment on the bottom. The bottle, with the stopper in place, should then be entirely submerged in the water and the stopper taken out at a distance of about twelve inches below the surface. When the bottle is full, the stopper is replaced below the surface, if possible, and finally secured as above. It will be found convenient in taking samples in this way to have the bottle weighted, so that it will sink below the surface. It is important that the sample should be obtained free from the sediment on the bottom of a stream and from the scum on the surface. If a stream should not be deep enough to admit of this method of taking a sample, the water must be dipped up with an absolutely clean vessel and poured into the bottle after it has been rinsed.

3. FROM A WELL.—Pump or draw the water in the usual manner, rinse the bottle and stopper, then fill, using all the precautions above mentioned, and seal as directed. The sample of water should be collected *immediately before shipping by express*, so that as little time as possible shall intervene between the collection of the sample and its examination.

NOTE. In order to interpret correctly the results of an analysis of a given sample of water it is necessary to take into account all the factors and conditions that may possibly impair its purity or in any manner affect its quality; therefore we desire that the following blank shall be filled out as accurately and as completely as possible and enclosed in the envelope tag used in shipping the sample to the Laboratory. No examination will be made unless these requirements are complied with.

SAMPLE OF WATER.

From .....
Name of town or city.

Collected and sealed by .....
Name and address.

.....

Collected from .....
State whether the water is from a tap, or from stream, pond, reservoir, spring, well, or

.....
other source:

.....

.....

Collected on .....
Give day, date, and hour of day.

If sample is from a well or spring near or about buildings, give particulars as follows:

Distance from privy .....
" " sinkdrain .....
" " cesspool .....
" " barnyards, etc. .....
Depth.....

Is the drainage slope from any of the above-named towards the well or spring? .....

If away from buildings, is the source from which sample was taken surrounded by or near to a field of grass, or plowed lands, manured land, in the woods, etc.? Give particulars fully:

.....

.....

Kind of soil and subsoil .....

.....

In case there are any abnormal or unusual conditions (other than above named) existing in the source of the water, mention the facts—as, for instance, if the streams are swollen by recent heavy rains, or are unusually low, or if there is anything remarkable in the appearance of the water, or if any taste or odor has been observed.

.....

.....

.....

.....

.....

Is there a suspicion that the water may be polluted? If so, state probable or possible source of contamination.....

.....

.....

.....

Is the water now suspected as a cause of illness? If so, state particulars.

.....

.....

.....

Signature .....

Address .....

Date.....190 .

Sample received ..... No.....

Upon receipt of the sample of water the tag envelope is opened, the blank form given a serial number, the bottle marked to correspond, and the number entered on the record book of the laboratory. A general sanitary analysis is made as soon as possible after the receipt of the sample, generally within twenty-four hours. The factors determined are the total and fixed solids, free and albuminoid ammonia, nitrates, nitrites, chlorine, hardness, color, odor, turbidity, sediment, and all general characteristics. If the water has passed through lead pipe, it is examined for lead, and if it appears that iron is present in any quantity the amount present is determined. If the water is suspected of causing typhoid fever, the specimen is examined bacteriologically, but in ordinary analysis we do not consider the bacteriological examination sufficiently necessary to warrant its being made in the case of the single samples that come to us.

These results, together with the information we have concerning the surroundings of the supply, enable us to determine the character of most of the polluted supplies and inform us as to the potability of the uncontaminated waters. Those waters which appear to be slightly polluted, but which are not sufficiently bad in quality to warrant condemnation, are kept under surveillance and repeatedly examined until the true character of the supply is determined.

RESULTS OF ANALYSES OF WATER SUPPLIES
ARRANGED IN ORDER OF THEIR EXAMINATION.

[Results are given in parts per 100,000.]

Number.	Date of collection.	Appearance.			Color.	Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.*
		Turbidity.	Sediment.	Odor.		Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
1	May 22	V. slight	Slight	Distinct veg.	0.0	2.9	1.8	.0015	.0275	.0048	.0000	.14	.....	.....	†g
2	May 22	V. slight	Slight	Faint veg.	0.0	.....	.....	.0013	.0122	.0048	.0000	.12	.....	.....	g
3	May 22	Slight	Cons.	Decided veg.	0.0	.....	.....	.0013	.0149	.0048	.0000	.13	.....	.....	g
4	May 23	Slight	Cons.	Decided veg.	0.0	2.5	1.2	.0013	.0137	.0050	.0000	.13	.....	.....	g
5	May 25	Slight	Slight	Decided musty	0.1	25.50	14.20	.0920	.0398	.2200	.0000	6.46	.....	.....	b
6	May 27	None	None	V. slight musty	0.0	5 60	4.20	.0011	.0000	.1250	.0000	.57	.....	.....	g
7	May 26	Slight	Much veg.	Slight veg.	0.4	4.10	1.90	.0018	.0155	.0600	.0000	.06	.....	.....	g
8	May 26	V. slight	Much veg.	Slight veg.	0.3	3.80	1.60	.0016	.0067	.0000	.0000	.08	.....	.....	g
9	May 26	V. slight	Much veg.	V. slight veg	0.25	4.70	1.60	.0012	.0073	.0000	.0000	.07	.....	.....	g
10	May 27	Distinct	Cons.	Mouldy, pungent	0.6	15.60	9.20	.0372	.0083	.0000	.0000	.07	.....	.....	‡b
11	May 28	V. slight	Slight	Distinct veg.	0.2	3.40	1.30	.0019	.0105	.0000	.0000	.09	.....	.....	g
12	May 29	None	V. Slight	Slight veg.	0.1	8.20	3.00	.0019	.0139	.3200	.0002	.35	.....	.....	b
13	May 29	None	None	Slight veg.	0.0	2.80	1.60	.0015	.0021	.0000	.0000	.07	.....	.....	g
14	May 30	None	Slight floc. veg.	Slight veg.	0.0	39 30	21.30	.0086	.0067	.8000	.0060	.90	.....	.....	b
15	May 30	None	Slight	Slight musty	0.0	10.70	5.60	.0002	.0024	.2000	.0002	3.37	.....	.....	b
16	June 2	None	Slight floc.	Slight veg.	0.0	3.50	1.00	.0021	.0005	.0266	.0000	.47	.....	.....	g
17	June 3	None	Much	Slight	0.1	3.60	1.20	.0014	.0057	.0066	.0000	.13	.....	.....	g
18	June 3	None	Much	Slight veg.	0.11	4.10	1.70	.0046	.0099	.0066	.0000	.13	.....	.....	g
19	June 3	None	Slight	Slight veg.	0.1	3.70	2 20	.0040	.0057	.0066	.0000	.13	.....	.....	g
20	June 8	Distinct	Slight	Foul musty	0.2	38.50	23.30	.1500	.2860	2.4000	.0040	4.66	.....	.....	b
21	June 8	None	Slight	Slight musty	0.0	18.60	11.20	.0028	.0183	.8000	.0001	1.09	.....	.....	b
22	June 10	V. slight	Slight	Slight musty	0.0	16.00	11.20	.0038	.0019	.8000	.0001	63	.....	.....	b
23	June 11	None	Cons.	None	0.0	6.50	4.10	.0030	.0002	.2000	.0000	.70	.....	.....	g
24	June 12	V. slight	Slight	Foul	0.0	5.20	2.50	.0052	.0001	.0000	.0000	.13	.....	.....	g

*Waters containing lead, although they may be otherwise good, are reported as "bad"; "g" stands for good, "b" for bad, and "d" for doubtful.

†High albuminoid ammonia, due to heavy rains.

‡Dynamite used in digging well.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
25	June 12	V. slight	Slight	Musty	0.0	57.20	30.40	.0030	.0090	3.6000	.0004	8.24	.....	.....	b
26	June 23	None	Slight floc.	Slight veg.	0.0	1.80	1.10	.0024	.0000	.0026	.0000	.19	.....	.....	g
27	June 24	V. slight	Slight floc.	Decided veg.	0.2	2.80	1.00	.0000	.0169	.0000	.0000	.18	.....	.....	g
28	June 24	None	Much veg.	Slight veg.	0.0	21.60	10.50	.0014	.0025	1.2000	.0000	2.12	.....	.....	b
29	June 25	None	Slight	Cons. veg.	0.0	20.00	7.20	.0024	.0060	1.2000	.0001	1.88	.....	.....	b
30	June 25	None	None	Faint veg.	0.0	4.40	2.80	.0000	.0000	.0166	.0000	.13	.....	.....	g
31	June 25	V. slight	Slight floc.	Foul	0.0	13.30	3.40	.0113	.0047	.6666	.0001	1.10	.....	.....	b
32	June 26	Much	Slight	Musty	0.0	36.60	26.30	.0158	.0000	1.0000	.0022	1.81	.....	.....	b
33	June 26	None	Slight floc.	Slight veg	0.3	4.60	2.80	.0000	.0115	.0000	.0000	.22	.....	.....	g
34	June 26	None	Cons.	V. slight	0.0	7.60	5.30	.0000	.0000	.0100	.0000	.31	.....	.....	g
35	June 26	V. slight	Much floc.	Musty	0.0	33.60	16.20	.0000	.0000	2.0000	.0002	6.07	.....	.....	b
36	June 26	None	V. slight	Faint musty	0.0	6.10	3.00	.0000	.0050	.0000	.0000	.67	.....	.....	g
37	June 26	None	V. slight	Slight	0.0	25.80	9.30	.0000	.0000	2.0000	.0000	2.17	.....	.....	b
38	June 27	None	V. slight	Faint musty	0.0	7.50	4.40	.0000	.0000	.1000	.0060	1.02	.....	.....	d
39	June 29	None	V. slight	V. slight	0.0	27.10	13.60	.0000	.0082	1.5500	.0000	2.95	7.80	.....	b
40	June 29	None	Slight	Decided musty	0.0	31.20	15.90	.0034	.0000	1.0000	.0003	5.37	8.90	.....	b
41	July 2	None	None	Slight	0.0	9.50	6.20	.0000	.0059	.1000	.0000	.90	5.70	.....	d
42	July 3	None	None	V. slight	0.0	12.50	8.90	.0006	.0096	.8000	.0003	1.34	5.90	.....	d
43	July 2	None	Much floc. veg.	Marked veg.	0.45	4.50	.30	.0000	.0186	.0000	.0001	.18	.....	.....	g
44	July 3	None	Much veg.	Decided veg.	0.6	3.60	.60	.0049	.0199	.0000	.0000	.14	.....	.....	g
45	July 1	None	None	None	0.0	0.80	.20	.0000	.0016	.0000	.0000	.15	.....	.....	g
46	July 3	None	None	None	0.0	7.80	4.00	.0000	.0016	.0300	.0000	.14	2.50	.....	g
47	July 4	None	None	Slight veg.	0.0	9.70	5.10	.0026	.0007	.4000	.0007	1.14	4.00	.....	d
48	July 5	None	Slight floc.	Aromat.	0.0	17.40	11.40	.0049	.0027	.0300	.0003	.43	10.00	.....	d
49	July 4	None	Slight	Decided veg.	0.0	4.40	2.20	.0000	.0046	.0400	.0003	.45	1.20	.....	g
50	July 4	None	Much floc. veg.	Strong fishy	0.0	10.70	4.20	.0000	.0028	.3000	.0001	.88	.....	.....	d
51	July 4	None	Slight floc.	Putrid veg.	0.0	6.90	3.60	.0000	.0040	.0400	.0002	.47	.....	.....	g
52	July 4	None	Cons. floc. veg.	Strong musty	0.0	11.40	4.80	.0000	.0024	.2500	.0001	1.18	....	.....	b
53	July 5	Marked	Much min.	None	0.0	6.70	4.10	.0073	.0090	.0000	.0000	.33	.....	.....	g
54	July 5	None	Cons. min.	None	0.0	6.00	3.40	.0028	.0100	.0900	.0001	.28	3.00	.....	g
55	July 8	None	None	Decided veg.	0.0	3.20	1.80	.0013	.0036	.0050	.0000	.34	1.50	.....	g
56	July 8	None	Slight floc.	None	0.0	17.10	9.50	.0008	.0038	1.5000	.0002	.84	6.00	.....	d
57	July 9	None	Floc. veg.	Decided veg.	0.12	5.00	2.00	.0009	.0104	.0050	.0002	.26	2.00	.....	g
58	July 9	None	None	Slight veg.	0.1	4.10	2.10	.0032	.0104	.0050	.0001	.20	1.90	.....	g

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
59	July 9	None	None	M. floc. veg.	0.12	4.70	2.20	.0032	.0135	.0050	.0002	.20	.....	.....	g
60	July 10	None	None	Decided veg.	0.7	4.50	2.50	.0074	.0167	.0050	.0003	.33	1.80	.....	g
61	July 10	None	None	Slight musty	0.0	32.20	17.20	.0048	.0070	1.5000	.0006	3.21	10.00	.....	b
62	July 12	Marked	Slight earthy	Slight mouldy	0.05	14.80	10.70	.0006	.0024	.6800	.0003	1.08	6.00	.....	d
63	July 12	None	None	Decided musty	0.0	25.80	19.70	.0044	.0030	.3000	.1600	1.21	10.00	.....	b
64	July 12	None	None	None	0.0	14.00	6.90	.0063	.0000	.0000	.0000	.63	6.00	.....	g
65	July 13	None	None	Decided mouldy	0.0	8.40	5.40	.0057	.0039	.1600	.0007	.37	.....	.....	g
66	July 15	None	None	None	0.0	13.50	8.20	.0000	.0052	.2500	.0000	1.44	.....	.....	d
67	July 15	None	Slight floc.	Decided mouldy	0.0	24.20	19.50	.0028	.0096	1.2500	.0007	4.04	7.10	.....	b
68	July 16	None	None	None	0.0	4.70	3.10	.0010	.0024	.0600	.0002	.22	2.40	.....	g
69	July 16	None	Slight floc.	None	0.0	6.00	3.70	.0014	.0026	.1000	.0000	.40	.....	.....	g
70	July 18	None	Slight floc.	Slight earthy	0.5	4.40	3.00	.0008	.0032	.0700	.0001	.21	2.40	.....	g
71	July 19	None	None	Decided mouldy	0.0	36.70	20.10	.0059	.0174	2.5000	.0032	5.27	10.00	.....	b
72	July 22	None	None	Slight mouldy	0.0	13.20	9.50	.0034	.0073	.6300	.0010	1.62	4.50	.....	b
73	July 22	None	None	None	0.0	14 90	13.30	.0016	0063	1.0000	0000	.75	8.00	.....	d
74	July 22	None	Slight	None	0.4	30.50	23.20	.0080	.0206	1.2500	.0024	1.87	14.50	.....	b
75	July 22	None	None	None	0.0	3.80	2.90	.0026	.0034	.0000	.0000	.13	2.40	.....	g
76	July 23	None	None	None	0.0	5.10	4.80	.0014	.0000	.0000	.0000	.07	2.40	.0150	g
77	July 23	None	Cons. floc. veg.	Slight veg.	0.15	6.40	5.60	.0016	.0020	.0040	.0000	.07	.....	.....	g
78	July 24	None	None	None	0.0	3.90	2.70	.0036	.0052	.0200	.0000	.14	.....	.0100	g
79	July 24	None	None	None	0.0	14.90	10.00	.0012	.0000	.6000	.0001	2.06	6.00	.....	d
80	July 24	None	Slight floc.	V. slight mouldy	0.0	16.60	9.50	.0046	.0068	.7000	.0000	1.68	....	.....	d
81	July 24	None	None	None	0 0	5.70	3.80	.0014	.0034	.0800	.0000	.49	....	..	g
82	July 24	None	None	None	0.05	3.30	1.90	.0000	.0000	.0030	0000	.14	.....	.....	g
83	July 25	None	Much floc. veg.	Decided veg.	0.0	5 30	3.90	.0006	.0031	.0200	.0000	.29	2.90	.....	g
84	July 26	None	None	Slight veg.	0.0	6.30	5.70	.0000	.0014	.2100	.0000	.36	4.00	.....	g
85	July 26	None	None	Faint veg.	0.0	17.80	9 50	.0020	.0072	.7200	.0000	1 41	6.40	.....	d
86	July 26	None	None	Faint musty	0.0	7.20	6.50	.0010	.0030	.1900	0000	.66	4.50	.....	g
87	July 26	None	Much floc. veg.	None	0.2	4.30	2 60	.0000	0096	.0200	.0000	.16	2.00	.....	g
88	July 26	None	Much floc. veg.	Faint veg.	0.2	4.00	2.20	.0032	.0130	.0050	.0000	12	1.60	.....	g
89	July 26	None	Much floc. veg.	Faint veg.	0.2	3.90	2.60	.0032	0114	.0050	0000	.12	2.40	....	g
90	July 26	None	None	None	0.0	2.40	2.10	.0000	.0018	.0060	.0000	.09	.....	.....	g
91	July 27	None	Much floc. veg.	Faint musty	0.0	9.80	7.10	.0067	.0061	.0400	0001	.71	....	.....	d
92	July 27	Marked	None	Faint	0.0	4.80	4.20	.0020	.0040	.0150	.0001	.39	3.60	1.7000	b

Analyses of Water Supplies.— Continued,

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
93	1901. July 30	None	None	Slight mouldy	0.0	5.00	3.50	.0000	.0014	.0480	.0014	.36	3.10	.....	d
94	July 30	None	Slight floc.	None	0.0	65.70	59.70	.0000	.0212	6.0000	.0037	6.13	17.20	.....	b
95	July 30	None	Slight floc.	Strong veg.	0.4	3.40	.80	.0000	.0242	.0000	.0000	.12	.....	.....	d
96	July 30	None	Much floc. veg.	Veg. and musty	1.1	4.30	2.20	.0036	.0180	.0000	.0000	.12	....	.....	*b
97	July 30	None	Slight	Decided mouldy	0.3	4.50	1.80	.0074	.0150	.0080	.0000	.12	.....	.....	d
98	July 30	None	Slight	Decided aromat.	0.4	3.20	1.20	.0028	.0184	.0000	.0000	.14	.....	.....	d
99	July 29	Marked	Much min.	Foul	0.2	6.80	3.50	.0018	.0170	.0560	.0075	.29	.....	.....	b
100	July 31	None	Slight	Musty foul	0.0	16.80	13.10	.0050	0202	.0200	.0033	.21	9.20	.....	b
101	Aug. 1	None	None	None	0.0	3.50	2.50	.0020	.0048	.0070	.0000	.17	2.40	.....	g
102	July 31	None	Slight floc.	Faint veg.	0.0	3.40	2.10	.0020	.0042	.0000	.0000	.14	2.00	.....	g
103	Aug. 1	None	None	None	0.0	4.80	2.70	.0028	.0022	.0100	.0000	.12	.....	.....	g
104	July 31	None	Much floc. veg.	Faint veg.	0.8	10.30	5.20	.0184	.0114	.2045	.0003	.69	5.10	.....	b
105	Aug. 5	None	None	Faint veg.	0.0	28.40	23.40	.0034	.0030	.2100	.0007	9.89	7.00	.....	b
106	Aug. 5	None	None	None	0.0	4.90	4.00	.0000	.0000	.0900	.0000	.39	2.80	.4800	b
107	Aug. 6	None	None	Decided veg.	0.12	3.30	.90	.0000	.0154	.0000	.0000	.11	.....	... ..	g
108	Aug. 6	None	None	None	0.0	38.80	34.00	.0000	.0038	.8000	.0000	7.74	11.00	.....	b
109	Aug. 7	None	None	None	0.0	5.50	4.40	.0000	.0000	.0300	.0000	.17	3.20	.....	g
110	Aug. 7	Faint	None	Aromat.	0.0	4.30	1.30	.0032	.0140	.0000	.0000	.09	.....	.....	g
111	Aug. 8	Marked	Much min.	Faint veg.	0.0	9.10	6.10	.0030	.0064	.0100	.0001	.10	5.20	.....	g
112	Aug. 12	V. slight	Slight min.	Faint mouldy	0.0	5.40	3.80	.0016	.0030	.0300	.0001	.18	...	.....	g
113	Aug. 12	Slight	Slight floc.	Decided veg.	0.1	4.00	1.40	.0014	.0156	.0000	.0000	.10	.....	.....	g
114	Aug. 12	None	Slight floc.	None	0.0	23.80	14.40	.0010	.0062	.7280	.0002	4.19	10.00	.....	b
115	Aug. 12	None	Much floc. earthy	Decided musty	0.0	16.10	9.80	.0030	.0060	.2030	.0003	3.41	.....	.....	b
116	Aug. 12	None	None	None	0.0	6.40	4.50	.0000	.0076	.0300	.0000	.14	....	.....	g
117	Aug. 13	Marked	Much floc. veg.	Strong musty	0.0	12.00	8.80	.0202	.0108	.0600	.0001	1.96	.....	.....	b
118	Aug. 15	None	Floc. veg.	Foul	0.0	4.00	1.20	.0016	.0134	.0570	.0000	.04	.....	.....	g
119	Aug. 10	None	None	None	0.0	6.10	4.80	.0000	.0000	.0001	.0000	.24	1.90	.....	g
120	Aug. 16	None	Slight floc.	Faint veg.	0.0	14.00	8.30	.0000	.0010	.7000	0000	1.13	3.05	.....	g
121	Aug. 15	Decided	Much floc. veg.	Foul mouldy	0.1	5.80	4.10	.0000	.0086	.0200	.0003	.24	1.80	.....	d
122	Aug. 15	None	V. slight floc.	None	0 0	10.50	5.40	.0014	0072	.2500	.0006	.72	5.10	.2400	b
123	Aug. 19	Slight	None	Foul	0.0	5.40	3.90	.0006	.0014	.0000	.0000	1.72	.....	.....	b
124	Aug. 19	None	None	None	0.0	14.80	11.30	.0000	.0044	.5000	.0000	.84	8.00	.....	g
125	Aug. 19	None	None	None	0.0	25.60	20.30	.0020	.0022	.1200	.0000	4.05	7.40	.....	b

*Iron, .2360.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.			Color.	Residue on Evap'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.		Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
126	Aug. 19	None	None	Faint veg.	0.0	11.20	7.40	.0012	.0070	.2000	.0000	.98	5.50	.....	d
127	Aug. 21	None	Slight floc. veg.	Slight veg.	0.1	3.50	2.30	.0006	.0016	.0140	.0000	.29	.....	.....	g
128	Aug. 21	None	None	None	0.0	25.30	18.30	.0012	.0044	1.2000	.0000	3.68	8.20	.....	d
129	Aug. 21	None	None	None	0.0	.....	.....	.0008	.0036	.0180	.0000	.34	.....	.....	g
130	Aug. 22	None	None	Faint veg.	0.0	4.90	3.50	.0010	.0000	.0340	.0003	.39	.....	.1280	b
131	Aug. 23	None	None	Faint veg.	0.0	11.80	6.30	.0014	.0000	.1850	.0003	2.40	4.20	.....	d
132	Aug. 23	None	Slight floc.	None	0.0	6.20	3.80	.0020	.0052	.0260	.0003	.09	.....	.....	g
133	Aug. 23	V. slight	Slight	Aromat.	0.0	6.80	3.70	.0000	.0088	.0550	.0000	.24	.60	.....	g
134	Aug. 26	None	None	None	0.0	15.30	6.10	.0000	.0010	.6000	.0000	.88	2.90	.....	d
135	Aug. 26	None	Slight floc.	Faint veg.	0.0	20.60	9.60	.0068	.0024	1.2000	.0044	.44	3.50	.....	*d
136	Aug. 26	None	None	None	0.0	4.30	2.40	.0009	.0000	.0000	.0000	.09	.....	.....	g
137	Aug. 27	None	None	None	0.0	10.40	5.70	.0052	.0038	.4108	.0000	.86	2.80	.....	g
138	Aug. 28	Marked	Slight floc.	Faint musty	0.0	21.10	13.30	.0030	.0056	1.1540	.0016	3.69	4.70	.....	b
139	Sept. 1	None	Slight floc.	None	0.0	3.50	2.70	.0000	.0022	.0280	.0000	.09	.....	.....	g
140	Sept. 2	None	None	Faint musty	0.0	21.60	16.40	.0032	.0074	1.5000	.0005	3.38	10.00	.....	b
141	Sept. 2	None	V. slight	Strong of gas	0.0	5.40	3.50	.0014	.0020	.0280	.0000	.27	.....	.....	†g
142	Sept. 4	None	None	None	0.0	.....	.....	.....	.....	.....	.....	.20	.....	M'ch	b
143	Sept. 3	Faint	Much floc.	Musty	0.3	44.00	36.30	.0110	.0204	2.0000	.0038	8.23	7.40	.....	b
144	Sept. 3	Slight	Much floc. veg.	Faint veg.	0.1	6.10	5.70	.0016	.0032	.0760	.0004	.31	1.40	1.1000	b
145	Sept. 4	Marked	V. much floc.	Foul musty	1.2	20.10	12.90	.0046	.0288	.0450	.0703	2.23	5.00	.....	b
146	Sept. 4	None	None	None	0.0	4.30	3.10	.0014	.0106	.0000	.0000	.10	.....	.....	g
147	Sept. 5	None	V. slight floc.	Faint musty	0.0	12.80	8.50	.0018	.0022	.8000	.0001	1.17	5.00	.....	d
148	Sept. 5	None	None	None	0.0	43.00	36.10	.0012	.0026	3.0770	.0002	4.35	9.60	.....	b
149	Sept. 7	Faint	None	Faint mouldy	0.0	21.70	16.40	.0034	.0080	.1520	.0016	4.08	8.00	.....	b
150	Sept. 6	None	None	None	0.0	45.90	40.60	.0046	.0062	.6400	.0001	5.53	9.70	.....	b
151	Sept. 6	None	Much floc.	Decided veg.	0.12	2.10	1.00	.0008	.0082	.0090	.0000	.10	.....	.....	g
152	Sept. 9	None	None	None	0.2	5.10	3.20	.0012	.0074	.0120	.0000	.23	.....	.....	g
153	Sept. 9	None	Slight floc. veg.	None	0.3	5.20	3.70	.0034	.0172	.0120	.0000	.23	.....	.....	g
154	Sept. 9	None	Slight min.	Faint veg.	0.0	7.80	4.90	.0014	.0058	.1400	.0000	.78	4.10	.....	g
155	Sept. 10	None	Much floc.	Sl. oily veg.	0.1	3.70	1.80	.0026	.0046	.0000	.0001	.19	.50	.....	g
156	Sept. 10	Slight	Much floc. and min.	Faint	0.0	14.60	10.30	.0010	.0046	.2340	.0000	3.13	5.50	.....	b
157	Sept. 11	None	None	None	0.0	3.70	2.30	.0000	.0032	.0420	.0000	.15	.....	.....	g
158	Sept. 11	V. slight	None	Faint	0.0	13.10	11.00	.0010	.0060	.0160	.0000	.09	4.20	.....	‡g

* Dynamite used in digging well. † Impregnated with illuminating gas.
‡ Same as No. 10.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evap'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
159	1901. Sept. 12	None	None	Decided veg.	0.15	5.10	3.30	.0016	.0112	.0000	.0000	.19	.....	.....	g
160	Sept. 12	None	Floc. veg.	Decided veg.	0.15	5.60	2.60	.0026	.0126	.0000	.0000	.19	.....	.....	g
161	Sept. 12	None	Floc. veg.	Decided veg.	0.15	6.80	2.60	.0024	.0108	.0000	.0000	.19	.....	.....	g
162	Sept. 12	None	None	Faint musty	0.0	34.40	20.40	.0020	.0070	1.2070	.0004	3.31	6.70	.....	b
163	Sept. 15	Slight	Floc. veg.	Musty	0.0	43.00	24.10	.0038	.0074	1.4000	.0010	8.89	7.40	.....	b
164	Sept. 16	Marked	Much min.	Mouldy	0.0	15.00	7.50	.0024	.0036	1.2000	.0014	.39	4.10	.....	d
165	Sept. 16	None	None	Foul musty	0.1	58.50	39.60	.0010	.1480	2.5000	.0002	7.44	9.70	.....	b
166	Sept. 17	None	Slight floc.	Faint earthy	0.0	8.90	5.60	.0000	.0024	.1800	.0000	.54	3.20	.....	g
167	Sept. 17	None	None	Faint veg.	0.0	13.40	9.00	.0000	.0010	.4000	.0000	2.19	3.70	.....	g
168	Sept. 19	Marked	Much floc.	Decided musty	0.0	38.50	31.10	.0026	.0148	2.0000	.0020	3.92	8.00	.....	b
169	Sept. 19	None	None	Foul musty	0.15	15.00	7.50	.0016	.0154	.0500	.0007	.58	5.29	.....	b
170	Sept. 22	Slight	Slight	Faint earthy	0.0	10.60	7.60	.0024	.0064	.2000	.0004	1.08	3.00	.....	b
171	Sept. 20	None	Slight veg.	None	0.0	3.70	1.60	.0054	.0116	.0333	.0000	.04	.....	.....	g
172	Sept. 23	None	None	None	0.0	19.70	12.60	.0040	.0054	1.3636	.0000	1.66	3.70	.....	d
173	Sept. 24	None	Floc. earthy	Faint musty	0.0	47.90	33.60	.0038	.0064	4.5450	.0004	3.48	8.40	.....	b
174	Sept. 24	Marked	Floc. earthy	Faint musty	0.0	35.70	19.80	.0026	.0052	1.7640	.0106	5.44	6.90	.....	b
175	Sept. 25	None	Floc. earthy	None	0.0	31.30	25.30	.0030	.0196	.9230	.0001	4.31	4.30	.....	b
176	Sept. 26	None	Much floc.	Foul musty	0.0	34.10	29.30	.0084	.0114	1.0520	.0003	6.27	7.10	.....	b
177	Sept. 26	None	Slight	Faint veg.	0.25	3.50	.60	.0028	.0180	.0000	.0000	.09	.....	.....	g
178	Sept. 26	None	Slight	Faint veg.	0.25	4.40	.90	.0026	.0180	.0000	.0000	.09	.....	.....	g
179	Sept. 29	None	None	Decided veg.	0.0	6.40	5.10	.0054	.0050	.1120	.0000	.62	4.40	.....	g
180	Sept. 27	None	None	None	0.0	3.90	2.20	.0036	.0036	.0180	.0011	.09	1.90	.3000	b
181	Sept. 30	None	None	Faint veg.	0.0	7.90	6.70	.0010	.0042	.0480	.0000	.29	4.00	.....	g
182	Sept. 30	None	Earthy floc.	None	0.0	12.70	8.10	.0000	.0016	.4000	.0000	.35	.40	.....	g
183	Sept. 30	Marked	Cons. earthy	Faint oily	0.0	16.30	9.40	.0062	.2044	.7690	.0077	.38	5.80	.....	b
184	Sept. 30	None	None	None	0.0	3.80	1.80	.0016	.0042	.0480	.0000	.03	.....	.....	g
185	Sept. 30	None	Floc. veg.	Faint veg.	0.2	3.70	1.90	.0026	.0096	.0000	.0000	.10	.....	.....	g
186	Oct. 1	None	Slight veg.	Decided veg.	0.12	2.80	1.30	.0016	.0166	.0000	.0000	.16	.....	.....	g
187	Oct 1	None	None	Faint veg.	0.0	18.70	14.20	.0010	.0028	1.0764	.0000	1.45	6.40	.....	b
188	Oct. 1	Marked	Much floc. veg.	Oily	0.8	7.00	6.00	.0080	.0102	.1200	.0010	.78	.....	.....	b
189	Oct. 2	None	None	None	0.0	6.90	4.80	.0090	.0034	.4200	.0000	.49	.....	.....	d
190	Oct. 3	None	Slight min.	Foul	0.0	49.50	40.80	.0344	.0140	1.4280	.0100	8.42	10.70	.....	b
191	Oct. 4	None	Slight earthy	Foul	0.0	5.70	3.60	.0044	.0110	.0000	.0000	.20	3.60	.....	g
192	Oct. 4	Slight	Much floc. veg.	Veg.	0.0	11.50	8.60	.0020	.0072	.4000	.0004	1.21	5.00	.....	b

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
193	Oct. 4	None	None	None	0.0	16.40	13.80	.0016	.0092	.4000	.0000	1.96	4.40	.....	g
194	Oct. 5	Slight	None	Decided foul	0.0	37.50	29.60	.1160	.0186	.1800	.0058	15.09	5.20	.....	b
195	Oct. 7	None	None	None	0.0	4.60	2.60	.0006	.0074	.0250	.0000	.09	....	.2800	b
196	Oct. 7	None	None	None	0.0	3.00	2.40	.0000	.0028	.0000	.0000	.07	2.20	.1600	b
197	Oct. 7	Slight	Slight floc.	Faint	0.05	4.30	3.30	.0050	0032	.0000	.0000	.24	....	.2600	b
198	Oct. 9	None	None	Decided veg.	0.3	3.80	2.20	.0020	.0086	.0060	.0000	.04	....	.....	g
199	Oct. 9	None	None	Decided musty	0.0	8.90	6.50	.0026	.0028	.1240	.0004	.76	4.50	.....	d
200	Oct. 10	None	Consid. veg.	Earthy veg.	0.0	4.40	2.80	.0040	.0078	.0420	.0000	.15	....	.....	g
201	Oct. 10	None	Floc. veg.	Decided veg.	1.4	5.60	2.20	.0042	.0276	.0000	.0002	.17	....	.....	d
202	Oct. 12	None	None	Aromat.	0.0	6.20	3.60	.0040	.0142	.0000	.0000	.17	....	.1600	b
203	Oct. 10	None	None	None	0.0	4.50	3.50	.0000	.0000	.0100	.0000	.08	....	.....	g
204	Oct. 10	None	None	None	0.0	9.20	8.00	.0050	.0020	.2000	.0000	.36	2.20	.....	g
205	Oct. 11	None	Silica	Slight	0.0	15.70	11.30	.0048	.0034	1.4000	.0001	1.17	3.80	.....	*b
206	Oct. 11	Marked	V. much rust	Foul musty	Red.	8.20	6.50	.0148	.0016	.0000	.0000	.78	....	.....	†b
207	Oct. 11	Marked	Much iron rust	Foul	Red.	9.50	7.30	.0138	.0124	.0840	.0009	.70	....	.....	†b
208	Oct. 11	None	None	Slight earthy	0.0	20.00	11 90	.0032	.0072	.2200	.0001	3.76	4.70	.....	b
209	Oct. 15	Marked	Floc. and min.	Foul	0.4	9.00	5.90	.0040	.0128	.1800	.0012	.31	3.90	.....	b
210	Oct. 14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.2000	b
211	Oct. 16	None	None	None	0.0	6.60	4.10	.0000	.0044	.0460	.0000	.61	3.50	.....	g
212	Oct. 16	None	None	None	0.0	11.40	7.20	.0040	.0106	.1400	.0012	.21	5.30	.....	d
213	Oct. 17	None	Slight floc.	None	0.0	4.90	1.90	.0026	.0090	.0310	.0002	.09	....	.....	g
214	Oct. 17	Slight	Much floc. and sand	Slight musty	0.0	3.80	3.30	.0040	.0088	.0300	.0009	.78	2.10	.....	b
215	Oct. 17	None	None	None	0.0	2.10	1.40	.0010	0070	.0000	.0000	.07	1.10	.....	g
216	Oct. 17	Slight	Much floc.	Musty	0.0	11.50	6.80	.0036	.0082	.7140	.0005	.31	3.50	.....	d
217	Oct. 17	None	V. slight	Musty	0.05	18.20	14.60	.0146	.0186	.5400	.0024	1.42	4.80	.....	b
218	Oct. 18	V. mark.	Slight min.	Foul musty	0.0	15.00	10.00	.0172	.0190	.5710	.0014	.32	4.20	.....	b
219	Oct. 18	None	None	Slight veg.	0.0	3.30	2.00	.0000	.0138	.0060	.0000	.07	1.10	.0920	b
220	Oct. 18	None	Slight floc.	None	0.0	4.00	2.70	.0000	.0042	.0220	.0000	.04	....	.0560	d
221	Oct. 21	None	Slight	Faint	0.2	37.00	27.10	.0058	.0300	2.0000	.0002	2.70	5.20	.....	b
222	Oct. 21	None	Slight	V. foul	0.0	7.90	5.20	.0610	.0240	.0000	.0001	.39	1.95	.....	b
223	Oct. 22	Slight	V. much floc.	Decided earthy	0.5	12.00	5.60	.0044	.0210	.0400	.0002	.39	5.00	.....	‡b
224	Oct. 25	Marked	Sli'ht min. and floc.	Foul	4.0	17.20	10.10	.0840	.0208	.0000	.0002	1.47	4.40	.....	¶b
225	Oct. 25	None	None	None	0.0	3.20	1.30	.0016	.0036	.1800	.0001	.09	....	.0550	d

* B. Coli Communis present. † Much iron present.

‡ Iron, .2000. ¶ Iron, 1.3000.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.			Color.	Residue on Evap'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.		Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
226	Oct. 25	None	Much floc.	None	0.1	3.40	2.20	.0010	.0020	.0000	.0000	.19	1.10	.....	g
227	Oct. 28	None	None	Veg.	0.0	4.90	3.90	.0022	.0074	.0000	.0000	.23	1.20	.0310	g
228	Oct. 27	None	Slight	Decided veg.	0.1	2.80	1.50	.0000	.0176	.0000	.0000	.21	1.20	.....	g
229	Oct. 27	None	Slight	Decided veg.	0.1	3.00	1.20	.0000	.0092	.0000	.0000	.23	1.20	.....	g
230	Oct. 28	None	None	None	0.0	5.30	3.00	.0012	.0160	.0000	.0000	.14	2.00	.0420	g
231	Oct. 28	None	None	Faint musty	0.0	17.20	10.80	.0014	.0054	.8330	.0007	1.47	4 80	.....	b
232	Oct. 28	.....	.....	.....	....	.....	.....	.0016	.0180	.....	.....	.09	....	.....	g
233	Oct. 28	None	Slight floc. and min.	Faint veg.	0.0	10.50	5.40	.0010	.0024	.4170	.0000	.90	2.70	.....	g
234	Oct. 28	None	None	Faint veg.	0.4	3.40	1.60	.0016	.0094	.0100	.0000	.06	....	.....	*g
235	Oct. 29	None	None	V. faint	0.0	21.60	12.80	.0016	.0086	1.0500	.0005	3.34	5.50	.....	b
236	Oct. 28	None	None	None	0.0	7.10	4.40	.0028	.0044	.0200	.0003	.07	....	.....	g
237	Oct. 28	None	None	None	0.0	9.20	5.30	.0028	.0054	.0200	.0003	.07	....	.....	g
238	Oct. 30	Marked	Much min.	Faint earthy	0.0	7.40	3.80	.0044	.0068	.0200	.0006	.49	2.90	.....	d
239	Oct. 30	Slight	Slight	Fishy	0.0	6.80	4.30	.0020	.0032	.1250	.0000	.46	1.50	.....	g
240	Oct. 30	None	None	Faint veg.	0.0	8.50	5.60	.0024	.0020	.0050	.0000	.04	1.90	.0080	g
241	Oct. 31	None	None	None	0.0	7.80	5.70	.0010	.0040	.0200	.0004	.07	2.40	.....	g
242	Oct. 31	Slight	Much floc. iron	Foul	0.0	18.00	12.60	.0240	.0036	.5000	.0160	1.96	4.50	.....	b
243	Oct. 31	None	None	None	0.0	32.70	26.50	.0026	0048	.3840	.0000	4.50	4.40	.....	b
244	Nov. 4	None	None	Slight foul	0.0	9.40	6.10	.0110	.0014	.3260	.0011	.68	3.90	.....	b
245	Nov. 4	None	None	Slight veg.	0.0	15.90	13.00	.0010	.0092	.5500	.0000	1.47	2.85	.....	b
246	Nov. 4	None	None	Faint	0.0	5.50	2.40	.0010	.0080	.0000	.0000	.19	....	.....	g
247	Nov. 5	None	None	Faint	0.0	35.60	27.50	.0050	.0272	2.0000	.0006	2.94	5.40	.....	b
248	Nov. 5	None	None	None	0.0	4.80	2.40	.0016	.0012	.1000	.0001	.19	....	.....	g
249	Nov. 5	Marked	Floc. veg.	Foul	0.0	31.10	20.80	.0062	.0080	.5000	.0012	2 94	8.10	.....	b
250	Nov. 5	Opales.	None	Slight	0.0	30.10	23.40	.0010	.0050	.2410	.0001	4.03	8.00	.....	b
251	Nov. 5	Slight	Floc. veg.	Slight	0.0	6.10	4.20	.0020	.0070	.0800	.0001	.98	4.50	.....	g
252	Nov. 5	None	None	Foul	0.0	22.50	14.30	.0070	0054	.0000	.0000	1.25	7.50	.....	†d
253	Nov. 5	None	None	.....	0.0	49.30	35 30	.0034	.0090	.6660	.0001	7 84	9.10	.....	b
254	Nov. 6	None	None	None	0.0	17.00	9.60	.0018	.0042	.4000	.0001	1.54	....	.....	b
255	Nov. 6	None	Slight floc.	None	0.0	36.30	23.00	.0122	.0052	1.3320	0009	4.60	....	.....	b
256	Nov. 6	None	Slight floc.	None	0.0	6.20	4.80	.0020	.0032	.4000	.0001	.98	....	.....	g
257	Nov. 6	None	None	Faint veg.	0.4	20.00	13.10	.0010	.0096	.0000	.0000	.09	....	.....	g
258	Nov. 6	None	None	None	0.0	11.90	9.30	.0000	.0060	.1200	.0001	1.40	....	.....	d

*Sulfurous acid, .0040.

†Sulfates present in large amount.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
259	1901. Nov. 6	None	None	None	0.0	19.30	16.20	.0034	.0068	.2100	.0001	3.82	.....	.....	b
260	Nov. 6	None	None	None	0.0	7.20	5.40	.0000	.0048	.0400	.0000	.09	.....	.....	g
261	Nov. 6	None	Much floc.	Slight musty	0.0	19.40	11.50	.0134	.0166	.4000	.0009	3.82	.....	.....	b
262	Nov. 7	None	Floc.	Faint grassy	0.0	56.80	40.30	.0008	0138	2.5000	.0020	9 87	6.70	.....	b
263	Nov. 7	None	None	Faint	0.0	67.60	47.80	.0042	.0092	2.0000	.0001	8.82	9.40	.....	b
264	Nov. 7	None	Slight	Slight musty	0.0	42.30	30.30	.0014	.0054	1.0000	.0004	3.43	7.50	.....	b
265	Nov. 7	None	None	None	0.0	42.60	34.20	.0014	.0042	.1000	.0001	5.01	10.60	.....	b
266	Nov. 7	None	None	None	0.0	72.10	48.20	.0026	.0094	1.6660	.0027	5.95	11.00	.....	b
267	Nov. 7	None	None	V. slight veg.	0.5	7.00	4.10	.0060	.0059	.4000	.0000	.19	.....	.....	g
268	Nov. 8	None	None	None	0.0	14.80	5.60	.0046	.0058	.5550	.0003	1.47	.....	.....	b
269	Nov. 8	None	None	Slight veg.	0.0	9.90	2.60	.0010	.0030	.0000	.0000	.09	.....	.....	g
270	Nov. 8	None	None	Slight veg.	0.0	8.40	7.00	.0048	.0046	.0500	.0000	.19	6.15	.....	g
271	Nov. 8	None	None	None	0.0	15.80	12.20	.0000	.0036	.1300	.0000	1.05	6.40	.....	b
272	Nov. 7	Marked	Much floc.	Foul	0.0	19.30	12.00	.0320	.0088	.3330	.0380	1.19	.....	.....	b
273	Nov. 8	None	Slight floc.	None	0.0	8.20	4.80	.0000	.0000	.0000	.0000	.05	2.30	.....	g
274	Nov. 8	None	None	None	0.0	6.40	3.40	.0034	.0068	.0200	.0000	.04	.....	.....	g
275	Nov. 8	None	None	None	0.0	12.50	10.30	.0012	.0044	.0000	.0000	.14	2.40	.0220	d
276	Nov. 10	None	None	Slight musty	0.0	22.10	14.30	.0000	.0066	2.5000	.0003	1.96	4.20	.....	b
277	Nov. 11	Slight	Floc.	Faint	0.5	25.20	16.30	.0028	.0382	.5890	.0000	3.11	5.00	.....	b
278	Nov. 20	None	None	None	0.0	5.00	3.80	.0000	.0014	.0000	.0000	.13	3.40	.....	*d
279	Nov. 19	None	None	None	0.0	19.10	13.40	.0004	.0022	.4545	.0000	1.76	7.30	.0150	b
280	Nov. 20	None	None	Faint	0.0	5.90	3.40	.0022	.0012	.2630	.0000	.53	.....	.....	g
281	Nov. 20	None	Slight min.	None	0.0	12.40	4.80	.0000	.0028	.3220	.0000	1.58	.....	.....	b
282	Nov. 20	None	Slight	None	0.0	28.20	19.10	.0008	.0036	1.2500	.0000	1.80	14.00	.....	b
283	Nov. 21	None	None	Musty	0.0	24.10	18.20	.0008	.0054	1.0000	.0003	2.69	7.90	.....	b
284	Nov. 21	None	Slight floc.	Veg.	0.0	3.80	2.30	.0010	.0026	.0000	.0000	.14	.....	.....	g
285	Nov. 21	None	None	Faint veg.	0.0	8.30	6.50	.0006	.0076	.0100	.0000	.14	.....	.....	g
286	Nov. 22	None	Slight	Slight veg.	0.0	13.90	10.20	.0030	.0069	.3330	.0000	2.05	8.10	.....	b
287	Nov. 25	None	Slight	Slight veg.	0.0	21.00	14.10	.0000	.0072	1.0000	.0000	1.76	6.50	.....	b
288	Nov. 25	Much clay	Slight clay	None	0.1	4.70	3.20	.0012	.0000	.0030	.0001	.13	.....	.....	†g
289	Nov. 25	None	None	Slight veg.	0.0	1.80	.90	.0006	0044	.0000	.0000	.04	.....	.....	g
290	Nov. 25	None	None	None	0.0	8.50	6.90	.0010	.0208	.0800	.0000	.13	4.80	.....	g
291	Nov. 25	None	None	None	0.0	9.10	6.90	.0014	.0040	.0500	.0000	.29	5.80	.....	g

* Much zinc present. † Water very turbid.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
292	1901. Nov. 26	None	None	None	*	10.70	6.60	.0018	.0058	.5000	.0000	1.61	.....	.....	b
293	Nov. 21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	3.70	.....	†g
294	Nov. 28	None	V. slight floc.	Decided veg.	0.0	5.00	3.80	.0082	.0030	.0000	.0000	.09	3.60	.0200	d
295	Nov. 26	None	V. slight floc.	Decided veg.	0.0	6.60	5 10	.0000	.0046	.0000	.0000	.27	.....	.....	g
296	Nov. 28	None	None	None	0.0	5.00	3.50	.0000	.0000	.1250	.0000	.18	.....	.....	g
297	Nov. 29	None	Slight floc.	None	0.0	18.40	13.40	.0038	.0044	.9440	.0000	2.35	3.60	.....	b
298	Dec. 2	None	None	Faint musty	0.0	15.90	11.70	.0000	.0044	.4500	.0000	1.99	3.20	.....	b
299	Dec. 2	None	Much iron	Slight veg.	0.1	5.70	3.40	.0000	.0014	.0700	.0000	.20	.....	.....	g
300	Dec. 2	None	V. slight	None	0.0	9.80	6.00	.0040	.0000	.3330	.0160	.76	3.20	.....	b
301	Dec. 1	None	V. slight	None	0.0	5.80	2.10	.0022	.0010	.1000	.0000	.19	1.90	.....	g
302	Dec. 3	Marked	Slight	V. foul	1.0	15.20	10.10	.0020	.0146	.1000	.0011	.63	8.00	.....	‡b
303	Dec. 3	None	None	None	0.0	9.70	7.60	.0010	.0024	.0080	.0000	.24	2.90	.....	g
304	Dec. 3	None	None	None	0.0	5.40	3.80	.0010	.0042	.0000	.0000	.12	1.60	.....	g
305	Dec. 2	Slight	V. much floc.	Foul	0.15	3.00	1.50	.0696	.0094	.0000	.0000	.08	.....	.....	b
306	Dec. 4	Slight	Much floc.	Decided veg.	0.6	3.00	1.80	.0000	.0094	.0000	.0000	.08	1.50	.0400	g
307	Dec. 3	None	None	None	0.0	5.40	4.20	.0010	.0008	.0820	.0000	.63	1.40	.....	g
308	Dec. 5	None	Slight floc.	Slight veg.	0.0	4.40	3.20	.0016	.0000	.0740	.0008	.09	.....	.....	g
309	Dec. 5	None	Floc.	Earthy	0.0	7.00	4.80	.0000	.0016	.0700	.0000	.98	....	.....	g
310	Dec. 6	None	Slight earthy	Slight earthy	0.0	9.40	5.70	.0052	.0018	.5000	.0001	.58	2.30	.....	g
311	Dec. 6	None	None	None	0.0	15.10	11.40	.0000	.0030	1.0000	.0001	2.74	3.10	.....	b
312	Dec. 6	None	Slight floc.	Slight veg.	0.0	4.60	2.10	.0010	.0030	.0200	.0000	.39	.....	.....	g
313	Dec. 6	Slight	Slight earthy	V. faint earthy	0.0	10.90	7.50	.0018	.0030	.2000	.0000	.74	2.70	.....	g
314	Dec. 6	None	None	None	0.0	13.90	11.60	.0026	.0220	.0400	.0002	.39	1.90	.....	d
315	Dec. 7	None	Slight	Slight veg.	0.0	4.60	3.60	.0006	.0020	.0400	.0000	.27	.90	.....	g
316	Dec. 6	Slight	None	None	0.0	10.30	5.70	.0020	.0114	.0400	.0002	.09	5.50	.....	g
317	Dec. 6	None	None	None	0.0	5.00	3.60	.0000	.0028	.0160	.0000	.19	1.60	.0460	d
318	Dec. 9	None	None	Slight veg.	0.05	3.70	2.80	.....	.....	.0160	.0000	.07	1.10	.0200	g
319	Dec. 8	None	Floc. veg.	Slight earthy	0.0	5.70	4.80	.0000	.0018	.0600	.0000	.53	2.20	.....	g
320	Dec. 9	None	None	Slight veg.	0.0	7.50	5.90	.0006	.0026	.0160	.0000	.09	2.70	.0800	b
321	Dec. 10	None	None	None	0.0	15.60	12.10	.0010	.0036	.3330	.0001	3.28	4.10	.....	b
322	Dec. 12	None	None	Slight fishy	0.0	28.90	21.80	.0010	.0080	1.0000	.0002	6.49	5.20	.....	b
323	Dec. 12	None	None	Decided veg.	1.0	4.50	2.40	.0050	.0600	.0000	.0000	.08	.70	.....	d
324	Dec. 12	None	None	Decided veg.	0.9	5.80	2.50	.0050	.0580	.0000	.0000	.11	.60	.....	d

*Bluish. †Examined to determine solvent action on lead pipe. ‡Iron, .2000.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
325	1901. Dec. 12	None	None	None	0.0	1.40	.40	.0000	.0082	.0000	.0000	.01	.....	.....	*g
326	Dec. 12	None	None	None	0.0	2.30	1.20	.0010	.0046	.0000	.0000	.01	.....	.....	*g
327	Dec. 10	None	None	Slight foul	0.0	9.30	7.00	.0000	.0076	.1250	.0002	.80	2.00	.....	g
328	Dec. 13	None	None	None	0.0	12.60	9.80	.0038	.0176	.3330	.0003	1.29	3.30	.....	b
329	Dec. 14	None	None	Slight veg.	0.0	4.60	3.10	.0016	.0038	.0500	.0003	.11	2.20	.0350	d
330	Dec. 18	None	None	Slight veg.	0.0	2.50	1.80	.0008	.0016	.0000	.0000	.09	.....	.0000	g
331	Dec. 18	None	Slight floc. veg.	Veg.	0.7	3.90	1.80	.0020	.0374	.0000	.0000	.12	.40	.....	g
332	Dec. 19	None	None	Decided veg.	0.0	4.80	2.40	.0010	.0016	.1250	.0000	.41	1.80	.2100	b
333	Dec. 19	None	Floc.	Slight earthy	0.0	9.60	5.20	.0006	.0030	.5350	.0000	1.27	2.40	.....	g
334	Dec. 19	None	Slight floc.	Peculiar earthy	0.0	16.70	13.30	.0030	.0370	1.6660	.0007	2.00	2.40	.....	b
335	Dec. 18	None	None	Slight veg.	0.0	3.50	2.50	.0000	.0032	.0180	.0000	.12	.40	.....	g
336	Dec. 19	None	Slight floc.	Foul	0.0	11.90	7.50	.0000	.0136	.2000	.0000	1.77	1.60	.....	b
337	Dec. 20	None	None	Slight veg.	0.05	3.40	2.80	.0008	.0034	.0400	.0000	.18	.80	.....	g
338	Dec. 20	None	None	Slight veg.	0.05	4.00	2.40	.0014	.0050	.0220	.0000	.16	.80	.....	g
339	Dec. 20	None	None	Slight veg	0.05	4.40	1.40	.0026	.0054	.0760	.0000	.30	.80	.....	g
340	Dec. 23	None	None	Slight earthy	0.0	6.40	4.30	.0030	.0052	.1100	.0000	.72	2.80	.....	g
341	Dec. 23	None	None	Decided veg.	0.0	3.90	2.00	.0000	.0022	.0000	.0000	.17	.65	.0000	g
342	Dec. 23	Marked	Floc. veg.	Strong earthy	0.2	29.80	25.10	.0036	.0148	.6660	.0001	8.88	3.40	.....	b
343	Dec. 23	None	None	Strong e't'y veg.	0.2	17.70	13.00	.0840	.0182	1.1100	.0200	2.52	3.10	.....	b
344	Dec. 19	.....	.....	.....	.....	3.20	.....	.....	.....	.....	.....	.....	.....	.....	†
345	Dec. 31	None	None	None	0.0	2.90	1.20	.0044	.0136	.0050	.0000	.09	.90	.....	g
346	1902. Jan. 1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.05	1.10	.0520	b
347	Jan. 3	Slight	Slight veg. and min.	Earthy veg.	0.2	5.30	3.80	.0074	.0076	.0400	.0000	.06	1.60	.....	g
348	Jan. 5	None	None	Veg.	0.2	2.50	1.10	.0032	.0162	.0000	.0000	.09	.40	.....	g
349	Jan. 5	None	None	Veg.	0.2	2.30	1.10	.0032	.0172	.0000	.0000	.08	.40	.....	g
350	Jan. 6	None	None	None	0.0	4.10	3.10	.0018	.0042	.0400	.0000	.12	1.10	‡	g
351	Jan. 6	None	None	None	0.0	5.10	3.10	.0024	.0080	.2100	.0000	.42	1.40	.0360	d
352	Jan. 6	Slight	Earthy	Slight earthy	0.0	5.90	4.00	.0026	.0064	.3000	.0001	.85	1.60	.....	g
353	Jan. 6	None	None	None	0.0	7.60	5.90	.0028	.0016	.1200	.0000	.30	3.10	.....	g
354	Jan. 6	None	Slight earthy	None	0.1	2.80	1.00	.0000	.0046	.0000	0000	.05	.....	.0480	b
355	Jan. 8	None	Slight floc. veg.	None	0.0	5.00	1.30	.0074	.0110	.0050	.0000	.47	.....	.....	g
356	Jan. 7	None	None	Slight earthy	0.0	4.80	3.10	.0022	.0024	.0750	.000	.20	2.20	.....	g
357	Jan. 11	None	None	Veg.	0.1	3.20	1.20	.0030	.0138	.0000	.0000	.14	1.10	.....	g

* Ice. † Magnesium sulfate, .4675. ‡ Trace.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
358	1902. Jan. 11	None	Floc.	Foul	0.0	13.10	11.80	.0060	.0038	.2000	.0005	.80	6.70	.....	b
359	Jan. 12	None	None	None	0.0	3.20	1.90	.0044	.0108	.0400	.0000	.27	1.40	*	g
360	Jan. 16	None	None	None	0.0	8.10	5.60	.0020	.0204	.1000	.0000	.37	5.10	.....	g
361	Jan. 17	None	None	Decided veg.	0.2	3.90	1.70	.0044	.0236	.0000	.0000	.07	1.10	.....	g
362	Jan. 20	None	None	None	0.0	5.00	2.90	.0024	.0098	.0900	.0000	.32	2.20	.....	g
363	Jan. 21	None	Floc. veg.	Faint grassy	0.0	7.00	4.80	.0048	.0088	.1000	.0000	1.26	2.60	.....	g
364	Jan. 20	None	None	None	0.0	5.00	1.50	.0064	.0132	.0150	.0000	.09	.....	.....	g
365	Jan. 20	None	None	None	0.0	2.50	.00	.0042	.0056	.0000	.0000	.02	.00	.....	†g
366	Jan. 20	None	None	None	0.0	3.00	.00	.0080	.0130	.0000	.0002	.03	.00	.....	†g
367	Jan. 20	None	None	None	0.0	3.80	.80	.0064	.0136	.0000	.0003	.05	.00	.....	†g
368	Jan. 20	None	None	None	0.0	3.10	.20	.0044	.0084	.0000	.0001	.02	.00	.....	†g
369	Jan. 21	None	None	Decided veg.	0.8	5.70	.20	.0054	.0204	.0000	.0000	.12	...	.....	g
370	Jan. 21	None	None	Decided veg.	0.7	5.50	.60	.0044	.0228	.0000	.0000	.16	.....	.....	g
371	Jan. 21	None	None	Decided veg.	0.7	5.70	1.00	.0020	.0188	.0000	.0000	.21	.70	.....	g
372	Jan. 21	None	None	Decided veg.	1.0	9.10	1.60	.0012	.0156	.0000	.0000	.17	.70	.....	g
373	Jan. 21	None	None	Decided veg.	0.7	7.20	2.20	.0052	.0230	.0200	.0002	.45	1.40	.....	d
374	Jan. 21	None	None	Decided veg.	0.5	6.50	1.70	.0024	.0100	.0000	.0000	.19	1.10	.....	g
375	Jan. 21	None	None	Decided veg.	0.3	4.50	1.70	.0010	.0098	.0000	.0000	.17	1.40	.....	g
376	Jan. 24	None	None	V. slight	0.0	11.90	8.50	.0010	.0064	.1900	.0000	1.62	4.20	.....	g
377	Jan. 24	V. slight	Slight floc.	V. slight	0.0	6.20	3.10	.0010	.0050	.3500	.0000	.31	2.60	.....	g
378	Jan. 25	None	None	Slight earthy	0.0	8.10	5.60	.0026	.0072	.2200	.0000	.50	3.30	.....	g
379	Jan. 26	None	Slight	Slight earthy	0.0	15.00	13.00	.0020	.0088	.3000	.0002	1.00	7.00	.....	g
380	Jan. 26	None	None	Slight clay	0.0	15.30	13.20	.0000	.0018	.6000	.0002	1.25	6.50	.....	d
381	Jan. 26	None	V. slight	None	0.0	14.90	9.10	.0010	.0034	.3500	.0001	1.00	6.80	.....	g
382	Jan. 27	None	Slight floc.	Faint earthy	0.0	8.00	4.60	.0018	.0056	.4000	.0000	.80	2.20	.....	g
383	Jan. 28	None	None	Slight	0.0	9.30	5.90	.0012	.0036	.5000	.0000	.41	2.20	.....	g
384	Jan. 28	None	Much min.	Decided	0.0	6.50	3.30	.0000	.0018	.0200	.0000	.09	2.70	.....	g
385	Jan. 25	None	V. slight	.....	0.0	7.40	4.90	.0012	.0064	.0400	.0001	.55	1.90	.....	g
386	Jan. 31	None	None	Veg.	0.0	5.10	2.80	.0000	.0054	.0050	.0000	.07	.60	.0000	g
387	Feb. 1	None	Floc.	Earthy veg.	0.2	5.90	1.30	.0000	.0086	.0210	.0000	.10	.....	.....	g
388	Feb. 3	None	None	None	0.0	8.50	4.40	.0012	.0062	.1500	.0000	.22	1.20	.0000	g
389	Feb. 5	Slight	Floc. veg.	Earthy	0.0	14.70	7.50	.0000	.0042	.9000	.0001	1.26	4.10	.....	d
390	Feb. 3	Marked	None	Earthy	0.0	9.70	6.10	.0000	.0052	.1000	.0000	.22	2.40	.....	g

* Trace. † Ice.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
391	1902. Feb. 5	Marked	None	None	0.0	14.10	8.50	.0054	.0080	.0000	.0000	.65	3.90	.....	g
392	Feb. 5	Marked	Earthy	None	0.0	12.80	8.10	.0012	.0062	.2100	.0001	.90	5.80	.....	g
393	Feb. 6	None	None	Decided veg.	0.2	6.10	2.60	.0000	.0090	.0000	.0000	.07	1.20	.....	g
394	Feb. 6	Marked	None	Woody	0.05	7.70	5.20	.0158	.0058	.0000	.0018	.22	3.70	....*	*d
395	Feb. 10	V. slight	Floc.	Slight foul	0.0	17.40	11.90	.0020	.0254	.7000	.0001	1.95	5.00	.....	b
396	Feb. 10	None	V. slight	V. faint	0.1	5.60	3.20	.0000	.0150	.0900	.0000	.32	3.10	.....	g
397	Feb. 10	None	None	None	0.0	10.10	5.60	.0020	.0070	.2800	.0003	.82	2.00	.....	g
398	Feb. 10	V. slight	V. slight	Veg.	0.12	3.90	1.90	.0044	.0136	.0000	.0000	.12	.90	.....	g
399	Feb. 12	None	None	None	0.0	3.10	2.20	.....	.....	.0000	.0000	.15	1.10	.0650	d
400	Feb. 12	.....	.....	.....	0.0	18.80	15.80	.....	.....	1.0000	.0001	2.20	5.10	.....	b
401	Feb. 12	None	Slight floc.	Slight grassy	0.0	9.10	5.40	.0000	.0024	.3000	.0000	1.00	2.20	.....	g
402	Feb. 14	None	None	None	0.0	11.50	6.60	.0000	.0014	.3200	.0000	1.16	4.20	.....	d
403	Feb. 12	None	None	Flat	0.0	2.60	1.20	.0144	.0016	.0000	.0000	.02	.00	.....	†g
404	Feb. 14	None	V. slight	Veg.	0.1	5.80	3.40	.0006	.0070	.0200	.0000	.10	1.60	.....	g
405	Feb. 14	None	None	Min. and veg.	0.0	1.80	.40	.0034	.0024	.0000	.0001	.04	1.00	.....	‡g
406	Feb. 14	None	None	None	0.0	2.40	.40	.0040	.0046	.0000	.0001	.03	.00	.....	‡g
407	Feb. 15	None	None	None	0.0	1.50	.40	.0006	.0010	.0000	.0000	.02	.00	.....	‡g
408	Feb. 17	None	None	Earthy	0.0	14.30	10.30	.0450	.0072	.6500	.0004	2.00	4.40	.....	b
409	Feb. 18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0000	g
410	Feb. 18	None	None	Slight foul	0.0	12.60	8.20	.0014	.0058	.8000	.0001	1.42	3.30	.....	b
411	Feb. 20	Slight	Slight floc.	None	0.0	6.50	2.20	.0028	.0048	.0500	.0000	.70	.90	.0220	b
412	Feb. 21	Marked	V. much floc.	V. slight	0.1	17.10	9.00	.0000	.0096	1.2000	.0053	1 50	4.00	.....	b
413	Feb. 21	Marked	Floc.	Foul	0.25	6.90	2.40	.0078	.0064	.0000	.0000	.30	2.30	.....	g
414	Feb. 22	None	None	Slight grassy	0.0	5.40	3.00	.0020	.0074	.0000	.0000	.10	1.10	.....	g
415	Feb. 24	None	White floc.	None	0.0	13.60	6.00	.0010	.0020	.8000	.0001	.35	4.00	.....	g
416	Feb. 25	None	Floc.	V. slight	0.0	20.70	13.30	.0010	.0030	.8500	.0000	3.07	8.10	.....	b
417	Feb. 26	None	None	Foul	0.0	37.40	28.60	.0014	.0082	1.0500	.0001	1.70	14.40	.....	b
418	Feb. 27	None	None	Faint earthy	0.0	4.70	2.90	.0000	.0000	.0500	.0000	.20	1.40	.1030	b
419	Feb. 28	Slight	Floc. veg., etc.	V. foul musty	0.0	20.70	16.40	.0310	.0130	.6000	.0037	2.50	6.10	.....	b
420	Mar. 3	None	None	None	0.0	12.00	7.30	.0000	.0014	.0600	.0001	.75	4.80	.....	g
421	Mar. 3	None	None	Earthy	0.2	3.90	.80	.0020	.0122	.0000	.0000	.05	2.40	.2000	b
422	Mar. 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.20	.1600	b
423	Mar. 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.20	.1100	b

* Iron, .1300. † Distilled water. ‡ Ice.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
424	1902. Mar. 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.40	.0265	g
425	Mar. 3	None	Slight floc.	Earthy	0.1	11.50	5.60	.0000	.0038	.5000	.0001	.62	2.40	.....	g
426	Mar. 1	V. slight	V. slight	Earthy	0.0	21.20	13.80	.0030	.0148	.5000	.0000	4.17	5.10	.....	g
427	Mar. 3	None	V. slight min.	V. slight earthy	0.05	8.80	7.10	.0010	.0000	.0800	.0000	.52	1.90	.....	g
428	Mar. 3	Marked	Much sand	Slight foul	0.2	21.50	13.10	.0088	.0088	.9000	.0010	1.57	5.70	.....	b
429	Mar. 3	None	V. slight	None	0.2	13.80	9.20	.0012	.0144	.2000	.0000	1.42	4.40	.....	d
430	Mar. 4	None	None	Slight earthy	0.0	15.10	8.30	.0000	.0024	.3000	.0000	2.28	4.10	.....	b
431	Mar. 4	None	None	None	0.05	72.80	62.60	.0020	.0074	1.8500	.0000	6.26	29+	.....	b
432	Mar. 5	Slight	Slight	Veg.	0.4	6.90	1.70	.0090	.0144	.0000	.0002	.15	1.90	.....	*g
433	Mar. 5	V. slight	Slight	None	0.0	14.70	9.80	.0000	.0126	.0650	.0000	.45	3.90	.....	g
434	Mar. 5	None	Slight floc.	None	0.0	5.60	3.30	.0000	.0000	.0400	.0000	.63	1.20	.8000	b
435	Mar. 6	Marked	Fine sed.	Decided foul	0.4	8.50	2.00	.0108	.0226	.0050	.0003	.10	2.30	.....	†d
436	Mar. 6	None	None	V. slight	0.0	13.30	9.30	.0000	.0000	.0000	.0000	.17	5.80	.0000	g
437	Mar. 6	Marked	Fine sed.	Decided veg.	0.3	7.70	4.30	.0010	.0126	.0200	.0000	.06	1.80	.0000	g
438	Mar. 8	None	None	None	0.0	.....	.....	.....	.....	.0000	.0000	.08	.....	.4400	b
439	Mar. 10	Slight	None	Slight musty	0.0	40.30	27.00	.0068	.0050	3.0000	.0020	1.62	7.70	.....	b
440	Mar. 12	None	None	Veg.	0.0	3.60	2.10	.0000	.0000	.0150	.0000	.05	1.20	.0940	d
441	Mar. 11	None	None	None	0.0	27.50	19.80	.0006	.0032	.8000	.0000	3.20	6.70	.....	d
442	Mar. 11	Slight	Floc.	Flat	0.0	2.10	.20	.0098	.0054	.0000	.0000	.05	.10	.0000	‡g
443	Mar. 12	Slight	None	Slight earthy	0.1	10.30	5.80	.0056	.0066	.2200	.0000	1.46	2.60	.....	b
444	Mar. 13	Slight	Floc. veg.	Veg.	0.3	9.10	2.20	.0018	.0076	.0100	.0000	.04	1.10	.....	g
445	Mar. 14	Slight	None	Slight earthy	0.0	12.00	6.10	.0006	.0024	.0700	.0000	.20	3.30	.....	g
446	Mar. 14	None	None	None	0.0	28.80	19.40	.0010	.0054	1.2000	.0003	6.10	9.00	.....	b
447	Mar. 17	None	None	None	0.0	.....	.....	.....	.....	.....	.....	.....	.60	.0250	g
448	Mar. 20	None	Floc. veg.	Decided veg.	0.25	3.30	2.40	.0010	.0092	.0150	.0000	.15	1.40	.....	g
449	Mar. 22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.32	1.50	.0800	b
450	Mar. 22	Marked	None	Faint earthy	0.15	2.90	1.50	.0010	.0060	.2500	.0000	.23	1.50	.....	g
451	Mar. 21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0240	g
452	Mar. 24	Slight	Slight floc.	Slight	0.1	.....	.....	.....	.....	.0000	.0000	.12	.10	.1800	b
453	Mar. 24	None	None	None	0.0	.....	.....	.....	.....	.0000	.0000	.11	1.20	.0050	g
454	Mar. 25	Marked	Slight	Musty veg.	0.45	4.50	1.70	.0020	.0128	.0000	.0000	.14	1.40	.....	g
455	Mar. 27	Slight	Slight	Veg.	0.23	1.60	.70	.0010	.0122	.0150	.0000	.07	.70	.....	g
456	Mar. 27	Slight	Slight	Veg.	0.23	2.00	1.00	.0020	.0076	.0000	.0000	.07	.70	.....	g

*Water from cistern. †Cistern water. ‡Distilled water.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
457	1902. Mar. 27	Slight	Slight	Veg.	0.32	3.10	.80	.0000	.0052	.0000	.0000	.07	.60	.....	g
458	Mar. 27	Marked	Slight	Veg.	0.12	2.10	.80	.0010	.0078	.0000	.0000	.11	.60	.....	g
459	Mar. 28	None	Slight floc.	None	0.0	20.60	12.50	.0018	0092	1.6000	.0001	1.78	7.10	.....	b
460	Mar. 31	Marked	None	V. foul, musty	0.1	26.80	20.20	1.6000	.0550	.3000	0020	1.56	6.40	.....	b
461	Apr. 2	None	None	Slight foul	0 0	5.20	3.50	.0016	0024	.0100	.0000	.21	2.40	.....	g
462	Apr. 1	Marked	None	Foul	*	13.90	9.10	.0000	.0032	.4000	.0000	2.00	3.10	.....	b
463	Apr. 3	None	None	Veg.	0.0	8.40	5.50	.0000	.0026	.0100	.0000	.50	3.30	.0280	d
464	Apr. 3	None	None	V. slight	0.0	10.40	6 50	.0000	.0038	.5500	.0000	.85	4.00	.0000	g
465	Apr. 7	None	Much floc.	Veg.	0.0	3.20	2.10	.0028	.0028	.0000	.0003	.15	1.50	.0000	g
466	Apr. 5	None	None	V. slight	0.0	9.90	3.50	.0000	.0066	.2100	.0080	.90	3.50	.....	b
467	Apr. 11	Slight	Slight	V. slight	0.0	12.30	5.60	.0000	.0000	.9500	.0000	.95	3.70	.....	g
468	Apr. 11	None	None	V. slight	0.0	6.30	3.50	.0000	.0080	.0150	.0000	.15	1.40	.0450	d
469	Apr. 10	.....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	....	.0000	g
470	Apr. 14	None	V. slight	Slight earthy	0.0	31.00	26.90	.0020	.0024	.2500	.0000	12.50	3.20	.....	d
471	Apr. 14	Marked	Slight	Foul	0.1	6.00	3.80	.0014	.0106	.1500	.0034	.45	2.40	.....	b
472	Apr. 15	None	None	Slight earthy	0.0	4.40	2.40	.0020	.0038	.5000	.0000	.22	2.40	.....	g
473	Apr. 15	None	None	None	0.0	19.10	14.00	.0010	.0024	1.3000	.0000	2.04	4.10	.0000	†b
474	Apr. 17	None	None	None	0.0	7.00	4.40	.0000	.0010	.0600	.0000	.16	2.20	.0515	b
475	Apr. 18	Slight	Slight veg.	Slight foul	0.0	22.20	13.30	.0070	.0038	1.4000	.0192	2.00	4 50	.....	b
476	Apr. 17	None	Slight	Slight	0.0	28.00	19.60	.0026	.0136	1.8000	.0000	1.50	4 40	.....	b
477	Apr. 18	None	Slight	None	0.0	7 00	1.80	.0000	.0034	.0200	.0001	.07	1 40	.5400	b
478	Apr. 21	Slight	Slight floc.	Slight earthy	0.15	9.40	7.40	.0008	.0022	.0000	0022	1.52	2.90	.....	b
479	Apr. 22	None	Floc.	None	0.0	3.00	2.10	.0016	.0056	.0000	.0000	.05	2.60	.....	g
480	Apr. 21	None	Slight veg. floc.	Slight veg.	0.4	6.90	2.50	.0016	.0146	.0000	.0000	.14	2.20	.0000	g
481	Apr. 21	None	Slight	Slight	0.0	24.20	19.10	.0060	.0058	1.5000	.0001	1.50	7.00	.....	b
482	Apr. 22	None	Earthy	Slight foul	0.5	11.70	8.70	.0038	.0046	.6000	.0001	1.09	2.20	.....	b
483	Apr. 22	None	Fine sed.	Slight	0 5	18.40	12.20	.0028	0064	8.000	.0000	1.55	5.70	.....	b
484	Apr. 22	None	Much veg.	None	0.0	12.00	7.80	.0000	.0024	.4800	.0001	1.70	1.60	.....	d
485	Apr. 22	Slight	Much floc.	Foul sewage	0.6	44.00	28.80	2.0000	.0900	2.3000	.0240	5.50	6.70	.....	b
486	Apr. 22	None	None	None	0.0	15.40	10.20	.0000	.0 28	.3000	.0000	3.89	2.70	.....	d
487	Apr. 22	None	None	None	0.0	16 80	14.50	.0000	.0000	.5500	.000	1.56	3.70	.....	g
488	Apr. 23	None	None	Slight earthy	0.05	7.80	4.20	.0000	.0000	.120	0000	.42	2.20	..	g
489	Apr. 23	None	None	Slight	0.0	6.80	1.90	.0010	0000	.0000	.0000	.10	1.80	.0000	g

*Milky. † B. Coli Communis present.

Analyses of Water Supplies. — Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
490	1902. Apr 26	None	None	None	0.01	....	....	.0000	.0012	.0000	.0000	.07	.90	.2770	b
491	Apr. 25	None	None	Slight foul	0.0	13.70	8.50	.0000	.0000	.0000	.0000	.37	5.00	.....	g
492	Apr. 26	V. slight	None	Decided veg.	0.2	5.80	1.2	.0000	.0084	.0000	.0000	.08	.90	.....	g
493	Apr. 28	None	None	Veg.	0.1	14.20	7.50	.0000	.0112	.5500	.0020	1.34	2.90	.....	b
494	May 3	None	None	None	0.0	28.60	17.50	.0006	.0040	1.1000	.0006	2.60	5.70	.....	d
495	May 4	V. slight	None	Decided veg.	0.55	3.50	1.70	.0000	.0098	.0000	.0000	.05	1.60	.....	g
496	May 4	None	Slight floc.	Foul	0.0	11.10	3.90	.0018	.0058	.5500	.0000	.68	3.50	.....	g
497	May 5	None	None	Veg.	0.5	4.00	1.90	.0006	.0056	.0200	.0000	.15	1.20	.....	g
498	May 5	None	None	None	0.0	9.70	5.60	.0026	.0034	.0800	.0000	.40	2.00	.....	g
499	May 5	Slight	None	Slight veg.	0.0	7.60	4.50	.0000	.0026	.2500	0000	.70	1.95	.....	g
500	May 5	Marked	None	Marked stable	0.3	7.80	2.10	.0036	0148	.0700	.0000	.40	1.60	.....	b
501	May 5	None	None	None	0.02	10.40	6.50	.0028	0086	.2000	.0000	.80	3.70	.....	g
502	May 6	None	Sand	Slight veg.	0.0	3.40	1.40	.0000	0030	.0200	.0002	.06	1.40	.2000	b
503	May 5	Slight	Much floc.	Slight musty	0.0	8.70	4.50	.0000	.0080	.3500	.0003	.75	2.20	.....	g
504	May 6	Marked	Slight	Decided foul	0.3	12.30	7.70	.0028	.0232	.1900	0000	.17	2.20	.....	d
505	May 6	Slight	Slight	Foul	0.0	11.60	7.30	.0034	0042	.4500	.0001	1.05	2.30	.....	d
506	May 6	Slight	None	None	0.0	6 80	4.10	.0012	.0038	.0250	.0000	.20	2.30	.....	g
507	May 6	None	None	None	0.0	49.20	34.10	.0000	.0052	1.1000	.0000	14.74	9.00	.....	b
508	May 6	None	None	None	0.0	8.10	5.80	.0000	.0030	.0000	.0000	.06	4.10	.0000	g
509	May 5	None	None	Marked veg.	0.5	43.20	21.70	.0320	.0406	1.5500	0038	5.5	7.75	.....	b
510	May 5	None	None	None	0.0	13.00	9.20	.0010	.0026	.5500	.0000	.72	4.20	.....	g
511	May 6	None	Slight sand	None	0.0	....	....	.....	.....	.....	.....	.06	....	.0650	d
512	May 9	None	None	None	0.0	5.20	3.50	.....	.....	.2200	.0000	.34	1.90	.0550	d
513	May 8	Marked	Much floc.	Foul	0.0	5.60	3.50	.0088	.0046	.1200	0000	.75	1.90	.....	b
514	May 12	None	Fibrous	Slight earthy	0.0	6 30	3.60	.0000	.0062	.0900	.0000	.45	1.50	.....	g
515	May 12	None	None	None	0.0	16 20	10.30	.0000	.0024	.8000	0000	1.64	4.00	.....	d
516	May 12	None	None	Slight veg.	0.0	8.40	5.70	.0030	.0000	.0600	.0000	.31	2.30	.0000	g
517	May 12	None	None	None	0.0	4.70	1.70	.0014	.0006	.0750	.0000	.09	.60	.0580	d
518	May 12	None	None	None	0.0	5.60	3.40	.0130	.0014	.3000	.0000	.25	2.30	.....	g
519	May 12	V. slight	None	Slight aromat	0.0	14.50	8.40	.0024	.0060	.3500	.0001	2.06	4.40	1.1000	b
520	May 13	.....	.....	.....	....	....	....	.. ..	.....	.....	....	.....	....	.2900	b
521	May 13	Slight	None	None	0.0	61.40	58 30	.0000	.0012	.1800	.0011	.90	4.80	3.3000	b
522	May 12	None	None	None	0.0	5.00	3.70	.0000	.0020	.0001	00 0	.27	3.70	.....	g
523	May 13	None	None	Slight aromat.	0.0	3.30	2.10	.0000	.0000	.0300	.0034	.21	1.10	.2600	b

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
524	1902. May 13	None	None	None	0.0	3.40	1.80	.0016	.0020	.0300	.0000	.17	1.10	.0610	b
525	May 14	None	None	None	0.0	.....	.....	.....	.....	.....	.....	.....	.....	.3250	b
526	May 15	V. slight	V. slight	None	0.05	15.50	10.50	.0000	.0024	.3200	.0000	1.14	6.00	.....	g
527	May 15	None	Much floc.	Foul	0.0	36.80	32.00	.0008	.0146	1.4500	.0008	3.09	8.20	.....	b
528	May 14	None	V. slight	Foul	0.0	23.00	16.56	.0020	.0028	.8000	.0003	4.59	3.90	.....	b
529	May 16	None	None	Slight foul	0.0	17.70	13.00	.0016	.0114	.4000	.0170	1.31	4.80	.....	b
530	May 16	None	None	Slight	0.0	7.90	3.40	.0000	.0032	.1100	.0000	.65	2.90	.....	g
531	May 19	None	V. slight	Slight veg.	0.05	3.20	.90	.0000	.0064	.0000	.0000	.13	.60	.....	g
532	May 19	None	V. slight	Slight veg.	0.1	2.80	.90	.0000	.0114	.0000	.0000	.13	.60	.....	g
533	May 18	Marked	V. slight	Slight	0.0	60.50	52.70	.0000	.0114	2.0000	.0001	10.18	5.10	.....	b
534	May 19	None	None	None	0.0	8.30	6.60	.0006	.0024	.1900	.0000	.49	4.40	.....	g
535	May 20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0750	g
536	May 21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0000	g
537	May 16	None	None	None	0.0	20.70	16.20	.0030	.0064	.7500	.0020	3.95	4.80	.....	b
538	May 10	None	None	None	0.0	18.50	11.30	.0052	.0034	.7000	.0006	1.27	7.40	.....	b
539	May 20	V. slight	None	Slight foul	0.0	9.10	4.50	.0000	.0010	.3200	.0000	.45	2.80	.....	g
540	May 21	None	None	None	0.0	18.00	13.00	.0006	.0016	.3600	.0000	1.81	6.40	.....	g
541	May 20	Marked	V. slight	None	0.0	24.20	14.70	.0000	.0064	.3100	.0003	6.25	4.20	.....	b
542	May 20	None	None	None	0.0	5.20	3.20	.0000	.0000	.0400	.0003	.06	2.30	.....	g
543	May 20	None	None	None	0.0	5.20	2.50	.0000	.0000	.0900	.0001	.06	2.30	.....	g
544	May 21	None	Floc. veg.	None	0.0	18.30	13.00	.0046	.0168	.1000	.0001	3.70	2.70	.....	b
545	May 19	Marked	None	Decided veg.	0.2	6.00	2.50	.0032	.0068	.0050	.0000	.11	2.00	.0600	b
546	May 22	Marked	Slight floc.	Strong oily	0.0	16.50	10.00	.0000	.0038	.5000	0002	1.54	4.50	.....	g
547	May 22	None	Floc. veg.	V. slight	0.05	25.70	19.70	.0306	.0084	1.4500	.0006	2.64	3.10	.....	b
548	May 21	None	Slight	V. foul	0.30	18.70	10.00	.0460	.0194	.7600	.0028	1.18	4.00	.....	b
549	May 24	None	None	V. slight aromat.	0.0	12.00	8.90	.0000	.0146	.4000	.0000	1.18	4.10	.....	b
550	May 23	None	None	V. slight foul	0.0	4.30	2.00	.0018	.0028	.1000	.0003	.27	1.90	.....	g
551	May 23	Marked	V. much floc.	Decided veg.	0.0	5.20	4.00	.0008	.0026	.1200	.0000	.29	1.80	.....	g
552	May 23	V. slight	Consid. fine sed.	None	0.0	7.60	4.50	.0026	.0018	.2300	.0000	.34	1.60	.....	g
553	May 26	None	None	Slight veg.	0 0	5.50	2.10	.0000	.0026	.2000	.0002	.34	1.60	.0700	b
554	May 26	Slight	Slight floc.	V. slight veg.	0.0	4.30	2.50	.0000	.0000	.0000	.0000	.11	1.40	.....	g
555	May 28	Slight	Slight floc.	V. slight veg	0.1	6.50	2.30	.0000	.0110	.0000	.0000	.09	2.10	.....	g
556	May 28	None	V. slight	None	0.0	3.40	1.50	.0000	.0032	.0000	.0000	.06	1.50	.....	g
557	May 28	Consid. whitish	Much floc. veg.	Earthy	0.0	5.60	1.50	.0000	.0000	.0000	.0000	.13	.90	.....	g

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
558	1902. May 29	None	None	None	0.0	.....	.....	.....	.....	.3100	.0000	.45	2.30	.2000	b
559	May 29	Marked	Slight	Slight foul	0.1	24.10	17.90	.0046	.0130	1.0500	.0017	2.68	3.90	.....	b
560	May 29	Marked	Much min.	Slight foul	0.05	11.30	6.70	.0046	.0600	.7500	.0005	.47	3.50	.....	d
561	May 29	None	None	Slight foul	0.0	6.30	2.80	.0000	0020	.0300	.0000	.15	2.30	.0130	g
562	June 2	Slight	Much floc.	Marked foul	0.0	7.60	5.60	.0000	.0152	.1200	.0011	.45	2.60	.....	b
563	June 2	Slight	Slight	Slight	0.0	5.20	3.60	.0000	.0024	.0400	.0000	.09	1.90	.....	g
564	June 2	V. slight	Slight	None	0.0	7.40	4.50	.0000	.0034	.3100	.0000	.81	2.30	.....	g
565	June 2	V. slight	Slight	None	0.0	4.60	2.70	.0010	.0010	.0150	.0000	.13	1.80	.....	g
566	May 31	None	None	None	0.0	9.00	4.00	.0000	.0022	.2900	.0000	.59	3.10	.....	g
567	June 2	Slight	Slight	Slight	0.0	36.40	24.40	.0082	.0016	1.9000	.0034	6.04	6.80	.....	b
568	June 2	V. slight	Much fine white	Decided	0.0	20.00	11.00	.0018	.0014	1.2000	.0077	3.04	5.50	.....	b
569	June 2	Slight	Consid. floc.	Slight foul	0.2	7.40	2.30	.0072	.0038	.1500	.0012	.36	2.20	.....	b
570	June 4	None	None	None	0.0	3.80	1.90	.0000	0000	.0000	.0000	.13	.40	.....	g
571	June 2	None	None	Slight	0.0	26.20	16.90	.0000	.0012	1.3000	.0000	2.27	7.40	.....	d
572	June 1	None	None	V. slight	0.0	4.70	2.70	.0000	.0014	.1300	.0000	.22	2.30	.1400	b
573	June 5	V. slight	Slight	Decided veg.	0.25	7.30	2.00	.0000	.0052	.0180	.0000	.09	1.90	.....	g
574	June 9	None	None	V. slight earthy	0 0	18.30	6.70	.0000	.0024	.2900	.0000	1.77	4.00	.....	d
575	June 9	None	None	Slight foul	0.0	11.90	3.90	.0000	.0026	.6000	.0000	.77	3.90	.....	g
576	June 9	None	V. slight	Decided aromat.	0.0	12.80	6.90	.0018	.0042	.0700	.0000	1.02	3.60	.....	g
577	June 9	None	None	None	0.0	10.20	7.60	.0014	.000 0	.4300	.0000	.77	2.20	.0880	b
578	June 10	None	V. slight	Decided foul	0.0	12.20	7 00	.0018	.0058	.1900	.0000	1.22	3.50	.0000	g
579	June 9	None	None	Slight aromat.	0.0	49.50	31.20	.0000	.0060	2.9000	.0001	4.09	8.10	.....	b
580	June 9	None	V. slight	Slight aromat.	0.0	50.00	36 10	.0000	0034	1.6000	.0010	7.95	11.20	.....	b
581	June 8	None	None	None	0.0	5.90	4.20	.0030	.0028	.0600	.0000	.25	1 80	.0260	g
582	June 10	Very milky	Much	Slight oily	0.0	10.70	6.60	.0008	.0018	.0300	.0002	.34	1.40	.1020	b
583	June 9	None	None	None	0.0	5.70	2.90	.0034	.0020	.1600	.0000	.59	1.50	.....	g
584	June 10	Slight	Slight floc.	Mucky	0.1	.....	.....	.....	.....	.0100	0000	.11	2.70	.0000	g
585	June 11	None	None	Slight veg.	0.55	6.60	1.50	.0000	.0092	.0200	0000	.14	1.20	.....	g
586	June 12	V. slight	None	None	0.0	9.70	5.10	.0010	0018	.4500	.0003	.45	2.60	.....	d
587	June 13	None	None	None	0.0	10.80	6.30	.0012	.0000	.1900	.0000	.51	4.20	.....	g
588	June 13	None	None	Slight veg.	0.0	16.10	14.30	.0010	0058	1.6100	0007	1.31	6.20	.....	b
589	June 13	V. slight	None	V. slight	0.0	7.40	3.60	.0012	.0000	.0700	.0000	.21	2 20	.....	g
590	June 13	None	Slight floc.	None	0.0	14 30	6.50	.0000	.0030	.5100	.0000	1.11	2.90	.....	g
591	June 13	V. slight	Slight	Decided veg.	0.15	5.30	1.50	.0016	.0146	.0000	.0000	.11	.70	.....	g

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.			Color.	Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.		Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
592	1902. June 13	V. slight	Slight	Decided veg.	0.1	6.20	1.60	.0000	.0124	.0000	.0000	.11	.70	.....	g
593	June 13	V. slight	V. slight	Slight	0.15	5.50	2.10	.0006	.0072	.0000	.0000	.11	.70	.....	g
594	June 13	V. slight	V. slight	Veg.	0.15	6.10	1.70	.0006	.0126	.0000	.0000	.11	.70	.....	g
595	June 13	V. slight	V. slight	Veg.	0.15	6.70	1.70	.0006	.0108	.0000	.0000	.12	.70	.....	g
596	June 13	None	None	Veg.	0.15	6.20	1.60	.0000	.0112	.0000	.0000	.11	.70	.....	g
597	June 16	None	None	None	0.0	3.80	2.20	.0000	.0010	.0000	.0000	.09	2.20	.0000	g
598	June 16	Slight	V. slight	Slight	0.1	8.90	5.90	.0000	.0132	.1200	.0000	.09	2.60	.....	g
599	June 16	None	None	None	0.0	7.50	5.60	.0000	.0010	.1000	.0000	.31	1.50	.....	g
600	June 16	None	None	Slight veg.	0.25	5.00	2.20	.0012	.0046	.0000	.0000	.09	1.80	.....	g
601	June 15	None	None	Decided	0.0	57.30	30.00	.0000	.0100	.3000	.0032	8.58	9.40	.5400	b
602	June 16	None	Slight fibrous	Slight veg.	0.0	21.80	17.10	.0000	.0028	1.0200	.0001	2.82	5.80	.....	b
603	June 17	None	None	Slight	0.0	4.30	2.90	.0014	.0000	.0100	.0000	.09	.70	.....	g
604	June 18	Slight	Slight	Decided veg	0.3	9.20	2.70	.0000	0136	.1100	.0000	.18	.70	.....	g
605	June 18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0001	.....	.....	.2300	b
606	June 19	None	None	None	0.0	11.10	7.30	.0000	.0000	.1800	.0000	1.59	3.10	.....	g
607	June 19	Marked milky	None	None	0.0	11.00	5.20	.0000	.0000	.0600	.0000	.18	3.20	.....	g
608	June 20	None	Slight	None	0.0	2.10	1.80	.0000	.0000	.1100	.0000	.54	1.80	.....	g
609	June 23	None	None	Decided veg.	0.0	15.80	9.10	.0000	.0000	.5000	.0002	1.62	4.10	.1000	b
610	June 23	None	None	None	0.0	12.10	8.90	.0000	.0034	.2000	.0001	.37	3.90	.....	g
611	June 23	None	None	Musty	0.0	15.80	7.10	.0000	.0014	.9100	.0011	.50	4.40	.....	g
612	June 23	None	None	None	0.0	11.30	6.90	.0020	.0000	.5000	.0002	.80	3.20	.0300	g
613	June 23	Marked	Much veg.	Foul	0.0	13.40	7.80	.0234	.0066	.2100	.0012	.90	3.50	.....	b
614	June 25	V. slight	V. slight	Aromat. veg.	0.2	7.00	2.60	.0006	.0082	.0330	.0000	.12	1.80	.....	g
615	June 25	None	None	Decided foul	0.1	26.50	17.50	.2280	.0164	1.0100	.0116	2.62	5.00	.....	b
616	June 24	Marked	Much red. floc.	Very foul	0.7	23.60	17.10	.0230	.0074	.1900	.0027	1.97	6.00	.....	b
617	June 26	V. slight	V. slight	Veg.	0.0	4.20	2.10	.0000	.0044	.0000	.0000	.12	1.50	.....	g
618	June 26	None	None	Foul	0.1	28.10	19.60	.0058	.0010	1.2000	.0005	2 30	7.70	.....	b
619	June 27	None	None	V. slight	0.0	8.50	5.90	.0000	.0000	.1100	.0000	.52	3.90	.....	g
620	June 27	None	None	None	0.0	8.20	3.60	.0000	.0000	.2100	.0000	.32	2.00	.....	g
621	June 27	None	Slight floc.	Slight aromat.	0.0	10.40	8.80	.0000	.0018	.0150	.0000	.27	4.50	.....	g
622	June 13	None	Floc.	Slight	0.0	7.00	4.40	.0000	.0010	.1400	.0000	.07	2.20	.....	g
623	June 30	None	None	V. slight foul	0.0	7.00	4.20	.0010	.0000	.0200	.0004	.36	3.70	.1050	b
624	June 30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0460	*b

* After standing twelve hours in pipe, lead, .1800.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1902.														
625	June 29	Marked	Much red floc.	None	0.4	10.40	6.10	.0000	.0070	.0000	.0000	.30	2.30	.....	*b
626	June 30	None	None	None	0.0	19.50	10.90	.0000	.0014	.5000	.0002	.68	7.70	.....	g
627	June 30	V. slight	None	Veg.	0.25	8.00	3.10	.0000	.0054	.0000	.0000	.10	2.30	.....	g
628	June 30	None	None	None	0.0	9.20	3.70	.0000	.0000	.0000	.0000	.30	3.50	.....	g
629	June 30	Slight	Slight	Veg.	0.26	7.80	3.10	.0006	.0084	.0000	.0000	.12	2.30	.....	g
630	June 30	Slight	Slight	Decided veg.	0.26	8.10	3.00	.0006	.0120	.0000	.0000	.07	1.90	.....	g
631	June 30	Slight	None	Decided veg.	0.26	6.40	2.50	.0060	.0072	.0000	.0000	.07	1.90	.....	g
632	June 30	None	None	None	0.0	12.90	8.80	.0010	.0098	.3000	.0000	.25	4.00	.0000	g
633	July 2	Marked	None	Strong aromat.	1.3	23.80	15.60	.0112	.0280	.0000	.0054	.20	10.70	.....	b
634	July 2	None	None	None	0.05	26.10	17.30	.1340	.0176	.1800	.0007	4.55	5.20	.....	b
635	July 7	Slight	Slight	None	0.35	9.80	2.10	.0000	.0092	.6300	.0003	.17	2.00	.....	g
636	July 7	None	None	Foul	0.1	25.90	15.10	.0000	.0084	.1200	.0001	1.60	6.20	.....	d
637	July 7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.10	.....	.0490	d
638	July 9	None	None	V. slight	0.2	11.30	6.90	.0000	.0128	.2000	.0000	1.05	3.20	.....	d
639	July 9	None	None	None	0.0	8.30	5.30	.0006	.0000	.1000	.0000	.47	3.50	.....	g
640	July 10	None	None	Foul	0.0	6.60	3.20	.0018	.0010	.0000	0000	.17	2.80	.....	g
641	July 9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0960	d
642	July 10	None	None	Slight	0.0	14.50	9.90	.0009	.0000	.8000	.0001	1.20	3.20	.0710	b
643	July 10	None	None	None	0.0	10.40	6.70	.0000	.0000	.3900	.0018	.70	3.20	.3400	b
644	July 10	Slight	Floc.	V. slight	0.0	14.60	9.70	.0000	.0026	.3100	.0002	1.30	3.30	.....	b
645	July 11	Slight	Much floc. veg.	Foul oily	0.0	41.20	29.40	.0030	.0018	.9000	.0080	6.50	10.00	.....	b
646	July 14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0000	....	.40	.3000	b
647	July 14	None	None	Decided veg.	0.6	4.70	2.20	.0000	.0098	.0200	.0000	.14	1.80	.....	g
648	July 14	V. slight	None	None	0.0	10.80	6.10	.0000	.0026	.0600	.0000	1.06	3.60	.....	g
649	July 14	None	V. slight	None	0.0	32.80	22.90	.0000	.0000	.2100	.0000	3.85	7.50	.....	b
650	July 14	None	None	None	0.0	10.90	6.80	.0000	.0044	.0150	.0000	1.60	2.40	.....	g
651	July 15	Marked	None	Very offensive	0.0	7.80	4.30	.0080	.0000	.2600	.0000	1.30	2.40	.....	d
652	July 16	None	None	None	0.0	.....	.....	.0020	.0060	.0700	.0020	....	.....	.....	d
653	July 16	None	None	V. slight	0.0	5.40	3.10	.0000	.0000	.0000	.0000	.12	1.20	.....	g
654	July 16	None	None	Slight earthy	0.0	7.50	4 40	.0000	.0024	.0600	.0001	.30	2.30	.....	g
655	July 16	None	V. slight	None	0.0	8.20	4.20	.0000	.0018	.0000	.0000	.12	3.90	.....	g
656	July 17	None	Brownish floc.	None	0.0	4.60	1.70	.0000	.0000	.0250	.0000	.10	.30	.0000	g
657	July 17	None	V. slight	V. slight	0.5	6.10	2.20	.0020	.0154	.0200	.0000	.15	2.20	.....	g

Iron, .2200.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1902.														
658	July 16	None	Much fine	None	0.0	4.30	2.10	.....	.....	.0000	.0000	.15	.60	.....	g
659	July 17	None	None	None	0.0	.....	.....	.....	.....	.0300	.0000	.15	5.50	.3400	b
660	July 18	None	None	Very offensive	0.0	20.00	14.80	.0160	.0146	.2800	.0058	2.55	5.20	.....	b
661	July 19	V. slight	Much floc. veg.	V. slight	0.05	5.50	1.40	.0000	.0020	.0000	.0000	.20	.60	.....	g
662	July 19	None	None	Decided foul	0.0	12.60	7.90	.0126	.0058	.2000	.0054	1.65	3.50	.4200	b
663	July 19	None	Slight	Slight	0.0	38.70	28.20	.0000	.0018	2.0000	.0003	4.87	7.40	.....	b
664	July 19	Slight	Much floc.	Decided	0.3	6.40	1.30	.0048	.0260	.0000	.0000	.20	1.20	.....	g
665	July 22	None	None	Slight foul	*	9.00	3.10	.0000	.0014	.2200	.0000	.15	2.50	.0800	b
666	July 22	None	None	Slight	0.1	16.50	10.60	.0000	.0072	.3200	.0003	1.20	5.50	.....	d
667	July 23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0940	b
668	July 24	None	None	Slight	0.0	15.80	8.80	.0000	.0034	.2700	.0000	1.11	5.40	.....	g
669	July 25	None	Fine reddish	Slight aromat.	0.0	9.40	5.70	.0000	.0016	.0000	.0000	.20	3.20	.0000	g
670	July 25	None	None	None	0.0	26.80	13.40	.0000	.0000	2.0000	.0001	1.66	6.20	.....	b
671	July 25	None	None	None	0.0	13.80	16.00	.0000	.0000	.3000	.0000	.15	1.50	.0000	g
672	July 26	None	None	None	0.0	22.30	11.90	.0000	.0000	4.8000	.0000	3.55	4.80	.....	b
673	July 26	None	None	Slight foul	0.0	13.30	5.20	.0014	.0016	.1800	.0000	.50	2.00	.....	g
674	July 27	None	None	None	0.0	16.20	10.20	.0000	.0026	.2800	.0015	.90	5.40	.....	b
675	July 29	None	None	Slight veg.	0.0	.....	.....	.....	.....	.0200	.0000	.15	2.30	.0460	d
676	July 29	None	None	None	0.0	18.50	6.10	.....	.....	.1200	.0000	.75	5.50	.....	g
677	July 29	None	None	None	0.0	17.00	9.00	.0000	.0000	.2000	.0000	.50	2.40	.....	g
678	July 30	None	None	None	0.0	19.50	13.40	.0000	.0040	.8200	.0000	.85	5.40	.....	d
679	July 30	None	None	Slight	0.0	19.90	9.40	.0000	.0020	.0900	.0000	.35	7.00	.....	g
680	July 29	None	None	Slight foul	0.0	36.10	24.50	.0000	.0014	1.1000	.0000	3.65	9.20	.....	†b
681	July 29	None	Slight	None	0.0	9.90	5.50	.0000	.0052	.0000	.0000	.10	4.70	.....	‡g
682	July 30	Marked	Much	Decided	1.0	13.60	7.60	.0000	.0146	.0000	.0000	.10	1.60	.....	§b
683	July 30	Marked	Much	Parsnip-like	0.4	15.60	5.00	.0024	.0380	.0000	.0000	1.50	2.40	.....	¶b
684	July 30	Marked	Much iron oxid	Peculiar	3.0	13.10	12.40	.1000	.0088	.0000	.0000	.37	6.40	.0000	**b
685	July 30	None	None	Slight foul	0.0	6.60	4.20	.0034	.0044	.0400	.0033	.27	4.20	.....	g
686	Aug. 4	Slight	Slight floc.	V. decid. veg.	0.5	4.90	1.40	.0000	.0098	.0000	.0000	.07	1.40	.....	g
687	Aug. 4	Marked	Floc.	Veg.	0.5	4.00	1.50	.0000	.0066	.0000	.0000	.07	1.50	.....	g
688	Aug. 4	None	None	None	0.0	6.40	4.20	.0000	.0000	.0600	.0000	.45	2.68	.....	g
689	Aug. 4	None	None	V. slight	0.0	.....	.....	.....	.....	.1800	.0000	.40	1.80	.0780	d
690	Aug. 2	None	None	None	0.0	12.40	7.20	.0000	.0000	.4200	.0002	1.05	3.60	.....	d

* Bluish. † Iron, .0150. ‡ Iron, .0250. § Iron, .2700.
¶ Iron, .1000. ** Iron, .8400.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1902.														
691	Aug. 4	None	None	None	0.0	3.90	2.20	.0000	.0000	.0200	.0000	.10	1.80	.0190	g
692	Aug. 2	None	None	None	0.0	17.30	11.60	.0022	.0050	.6350	.0000	2.95	3.70	.....	g
693	Aug. 5	None	None	None	0.0	.....	.....	.....	.....	.0000	.0000	.10	1.60	.1020	h
694	Aug. 5	None	None	V. slight	0.0	4.40	3.70	.0000	.0000	.0150	.0000	.10	2.30	.0280	g
695	Aug. 5	None	None	None	0.0	5.80	4.50	.0026	.0000	.0980	.0000	.20	3.80	.....	g
696	Aug. 4	None	None	V. slight	0.0	.....	.....	.....	.....	.0400	.0000	.12	2.00	.1240	b
697	Aug. 5	None	None	None	0.0	5.30	3.20	.0000	.0000	.0330	.0000	1.25	1.90	.....	g
698	Aug. 6	None	None	None	0.0	.....	.....	.....	.....	.0100	.0000	.05	2.30	.1720	b
699	Aug. 8	Marked	Large mass floc.	V. foul	0.3	10.70	3.70	.0016	.0222	.0000	.0000	.40	3.70	.....	g
700	Aug. 8	None	None	Slight	0.0	35.80	25.30	.0000	.0000	1.2000	.0019	2.82	8.10	.....	b
701	Aug. 8	None	None	V. slight	0.1	67.00	52.30	.0000	.0024	.9500	.0003	3.62	9.00	.....	b
702	Aug. 8	None	None	Slight	0.0	40.50	30.00	.0112	.0052	1.2000	.0002	9.70	10.70	.....	b
703	Aug. 9	None	None	None	0.0	.....	.....	.....	.....	.0000	.0000	.12	2.60	.3900	b
704	Aug. 9	None	Slight floc.	None	0.0	15.90	9.30	.0018	.0000	.1500	.0000	.85	7.00	.....	g
705	Aug. 8	None	None	None	0.0	17.40	10.00	.0000	.0000	.1500	.0000	.72	9.00	.....	g
706	Aug. 11	None	Slight floc.	None	0.0	.....	.....	.....	.....	.0300	.0000	.26	2.30	.....	g
707	Aug. 12	None	None	None	0.0	17.00	9.80	.0000	.0040	.5500	.0002	.45	5.50	.....	g
708	Aug. 12	Marked	Much reddish floc.	Decided foul	0.3	11.00	5.70	.0054	.0032	.0000	.0000	.55	4.10	.....	*b
709	Aug. 12	None	Slight	None	0.0	9.50	3.40	.0000	0000	.0500	.0000	.17	2.70	.0000	g
710	Aug. 12	V. slight	None	Peaty	0.0	10.90	5.80	.0000	.0014	.0400	.0000	.40	3.20	.1020	b
711	Aug. 13	Slight	Floc.	Foul	0.0	.....	.....	.....	.....	.0400	.0000	.15	1.90	.0180	g
712	Aug. 13	None	None	Slight veg.	0.0	3.50	2.40	.0000	.0018	.0200	.0000	.10	2.40	.0215	g
713	Aug. 14	None	None	Slight earthy	0.0	15.70	13.00	.0010	.0032	.6500	.0001	1.65	3.60	.....	d
714	Aug. 14	None	None	None	0.0	5.80	4.30	.0000	.0018	.0200	.0000	.20	2.40	.....	g
715	Aug. 14	None	None	None	0.0	16.90	8.90	.0000	.0018	.8300	.0006	.75	6.10	.....	b
716	Aug. 14	None	None	None	0.0	11.50	8.40	.0010	.0018	.3000	.0000	1.50	1.80	.....	g
717	Aug. 14	None	None	None	0.0	.....	.....	.....	.....	.0200	.0001	.10	1.40	.0720	b
718	Aug. 14	None	None	Slight foul	0.0	37.80	25.40	.0006	.0078	1.6500	.0001	2.00	9.10	.....	b
719	Aug. 14	Slight	None	Foul, oyster-like	0.0	5.50	2.70	.0010	.0082	.0000	.0000	.10	2.70	.....	g
720	Aug. 14	V. slight	V. slight floc.	None	0.0	16.00	8.30	.0012	.0102	.4800	.0008	1.75	4.20	.....	b
721	Aug. 16	None	None	None	0.0	....	.....	.....	.....	.0000	.0000	.10	1.60	.0512	d
722	Aug. 18	None	None	Slight veg.	0.0	.....	.....	.....	.....	.0015	.0860	.10	6.20	.0860	b
723	Aug. 19	Slight	None	Decided veg.	0.35	7.30	3.00	.0010	.0144	†	.0000	.30	2.30	.....	g

* Iron, .5800. † Trace.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
724	1902. Aug. 18	Marked milky	None	None	0.40	15.10	8.70	.0026	.0054	*	.0000	.10	2.70	.....	b
725	Aug. 19	None	None	None	0.0	32.20	24.70	.0010	.0026	1.8000	.0005	4.25	6.80	.....	b
726	Aug. 22	None	None	None	0.0	28.00	17.70	.0006	.0038	.8000	.0000	3.45	6.80	.....	d
727	Aug. 22	None	Floc. veg.	Veg.	0.35	7.40	1.30	.0000	.0106	.0000	.0000	.17	1.20	.....	g
728	Aug. 22	None	None	None	0.0	22.60	13.40	.0000	.0000	.6000	.0007	2.90	7.20	.....	d
729	Aug. 22	None	Floc.	Decided foul	0.0	12.70	7.80	.0096	.0020	.0000	.0000	.45	6.00	.....	d
730	Aug. 22	None	None	None	0.0	3.60	2.50	.0000	.0014	.0000	.0000	.25	2.40	.....	g
731	Aug. 22	V. slight	Slight floc.	Slight veg.	0.0	.....	.....	.....	.....	.0000	.0000	.07	1.50	.1600	b
732	Aug. 22	None	None	None	0.0	.....	.....	.....	.....	.0000	.0000	.06	1.60	.1780	b
733	Aug. 22	None	None	None	0.0	10.30	8.00	.0010	.0014	.1200	.0001	2.20	3.90	.....	g
734	Aug. 22	None	None	V. slight	0.0	22.20	12.70	.0000	.0000	.3000	.0000	2.80	4.70	.....	g
735	Aug. 22	None	Slight reddish	None	0.0	16.60	12.40	.0000	.0000	.1800	.0000	4.10	4.10	.....	g
736	Aug. 22	None	None	None	0.0	13.50	8.90	.0000	.0000	.2100	.0001	2.05	4.00	.....	g
737	Aug. 25	None	Veg.	Slight foul	0.0	6.60	3.10	.0050	.0316	.0700	.0003	.35	2.80	.0260	b
738	Aug. 24	Marked	Slight	Very foul	0.0	41.10	19.20	.0544	.0360	.9500	.0120	3.95	12.40	.....	b
739	Aug. 25	None	None	None	0.0	6.80	6.60	.0000	.0150	.0500	.0000	.17	6.50	.0390	d
740	Aug. 25	None	Slight	Slight aromat.	0.0	6.80	4.90	.0000	.0020	.3000	.0000	.15	4.70	.....	g
741	Aug. 25	None	None	Slight	0.0	60.00	43.30	.0000	.0470	4.5000	.0020	5.15	10.30	.....	b
742	Aug. 25	None	None	Slight	0.0	31.80	21.60	.0000	.0014	1.0200	.0003	2.55	9.00	.....	b
743	Aug. 25	None	None	V. slight	0.0	5.80	3.80	.0006	.0014	.0300	.0000	.40	3.80	.....	g
744	Aug. 25	None	None	Slight veg.	1.20	6.20	2.00	.0010	.0190	.0200	.0000	.15	1.90	.....	g
745	Aug. 26	None	None	None	0.0	5.90	4.50	.0000	.0000	.0100	.0000	.07	2.60	.....	g
746	Aug. 26	None	None	None	0.2	3.70	1.30	.0000	.0060	.0120	.0000	.12	1.20	.....	g
747	Aug. 26	None	V. slight	Slight veg.	0.15	3.90	1.50	.0016	.0050	.0000	0000	.06	.40	.....	g
748	Aug. 26	None	None	Slight foul	0.0	18.70	15.00	.0000	.0000	1.1000	.0000	1.20	5.50	.....	d
749	Aug. 26	V. slight	Decid. floc. reddish	Marked veg.	0.5	7.80	2.89	.0000	.0202	.0900	.0000	.37	2.80	.....	g
750	Aug. 26	None	None	Slight veg.	0.0	6.00	1.50	.0000	.0000	.0000	.0000	.15	1.50	.....	g
751	Aug. 27	None	V. slight	None	0.15	6.50	2.80	.0000	.0000	.0000	.0000	.10	1.50	.....	g
752	Aug. 27	None	None	Slight	0.0	47.10	34.70	.0066	.0020	3.1000	.0008	6.85	10.10	.....	b
753	Aug. 27	None	None	None	0.0	12.40	8.70	.0000	.0000	.0200	.0000	.12	3.90	.....	g
754	Aug. 29	None	None	V. slight	0.3	5.30	2.00	.0000	.0110	.0000	.0000	.10	1.50	.....	g
755	Aug. 29	None	None	Slight musty	0.0	12.00	8.20	.0000	.0010	.5000	.0003	.85	3.90	.....	d
756	Aug. 29	Slight	Slight	Veg.	0.0	27.60	12.80	.0010	.0032	1.1000	.0013	2.60	8.70	.....	b

* Trace.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1902.														
757	Aug. 29	None	None	Slight	0.0	7.50	4.00	.0010	.0014	.0300	.0000	.45	3.70	.....	g
758	Aug. 29	None	None	None	0.0	55.20	43.40	.0104	.0020	2.5500	.0160	6.10	14.60	.....	b
759	Aug. 29	None	None	Slight	0.0	8.90	6.70	.0000	.0000	.0300	.0000	.30	4.10	.....	g
760	Aug 28	None	None	Slight	0.0	60.10	46.00	.0040	.0112	.0300	.0017	.65	8.10	.....	b
761	Sept. 2	None	None	None	0.0	6.00	2.50	.0000	.0028	.0700	.0000	.22	1.80	.....	g
762	Sept. 1	None	V. slight	V. slight veg.	0.1	4.80	1.90	.0000	.0044	.0150	.0000	.05	.30	.....	g
763	Sept. 2	None	None	V. slight foul	6.0	39.20	25.30	.0000	.0034	1.9500	.0000	3.07	10.90	.....	b
764	Sept. 2	None	None	None	0.0	7.70	6.70	.0000	.0000	.0220	.0000	.12	4.80	.0120	g
765	Sept. 1	None	None	None	0.0	5.50	3.60	.0000	.0024	.0300	.0000	.05	1.80	.....	g
766	Sept. 2	V. slight	Slight floc.	None	0.0	5.60	4.30	.0000	.0000	.0000	.0000	.05	3.20	.....	g
767	Sept. 1	None	None	Foul	0.0	15.10	7.10	.0320	.0098	.5500	.0002	1.35	5.50	.....	b
768	Sept. 2	None	None	None	0.0	11.50	8.10	.0000	.0012	.4000	.0000	1.00	6.80	.....	g
769	Sept. 3	V. slight	None	Foul	0.0	5.20	3.10	.0046	.0022	.1000	.0003	.17	3.10	.....	g
770	Sept. 3	None	None	Slight musty	0.0	15.36	11.70	.0940	.0108	.6100	.0018	.95	4.80	.....	b
771	Sept. 3	None	None	None	0.0	6.10	3.90	.0000	.0000	.0300	.0000	.06	3.60	.....	g
772	Sept. 3	None	V. slight	None	0.0	8.40	4.70	.0000	.0018	.0250	.0000	.08	4.70	.....	g
773	Sept. 2	None	None	None	0.0	21.30	16.70	.0000	.0050	1.5500	.0002	1.62	6.70	.....	b
774	Sept. 3	None	None	Decided veg.	0.2	6.10	1.60	.0020	.0074	.0000	.0000	.12	1.60	.....	g
775	Sept. 4	None	None	Decided veg.	0.1	4.30	1.50	.0000	.0102	.0000	.0000	.12	1.50	.....	g
776	Sept. 5	None	None	None	0.0	5.20	3.70	.....	.....	.0000	.0000	.06	2.70	.1510	b
777	Sept. 5	None	V. slight	Slight veg.	0.0	14.10	8.70	.0028	.0110	.6000	.0000	.99	5.40	.....	d
778	Sept. 4	None	V. slight	None	0.0	4.30	3.10	.0000	.0600	.0350	.0000	.10	2.00	.....	g
779	Sept. 5	None	V. slight	None	0.0	6.40	3.20	.0000	.0000	.0300	.0000	.12	2.90	.0560	d
780	Sept. 6	None	None	Slight foul	0.0	9.20	5.80	.0012	.0030	.0900	.0000	1.10	2.80	.....	g
781	Sept. 6	V. slight	None	V. slight	0.0	14.10	8.40	.0012	.0084	.2800	.0000	1.97	5.70	.....	b
782	Sept. 6	None	None	Slight earthy	0.0	7.40	3.50	.0000	.0030	.0220	.0000	.27	3.10	.....	g
783	Sept. 6	None	None	V. slight	0.0	8.50	4.00	.0000	.0000	.3000	.0000	.10	2.70	.....	g
784	Sept. 8	None	None	None	0.0	15.20	9.50	.0012	.0028	.3500	.0003	.85	5.50	.....	g
785	Sept. 9	None	None	None	0.0	13.00	4.60	.0000	.0010	.3500	.0000	1.50	3.90	.0330	d
786	Sept. 9	V. slight	V. slight	Slight veg.	0.25	8.70	1.50	.0000	.0036	.0000	.0000	.10	1.40	.....	g
787	Sept. 9	None	None	None	0.0	11.10	7.60	.0000	.0028	.0900	.0000	.62	7.50	.....	g
788	Sept. 9	None	None	Slight veg.	0.45	8.30	2.40	.0014	.0100	.0100	.0000	.15	2.40	.....	g
789	Sept. 9	None	None	Slight veg.	0.45	10.10	1.80	.0000	.0142	.0000	.0000	.11	1.50	.....	g
790	Sept. 10	Slight	Consid. veg.	Slight veg.	0.25	9.80	1.20	.0000	.0120	.0000	.0000	.35	1.10	.....	g

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
791	1902. Sept. 10	None	None	None	0.0	6.60	5.10	.0000	.0000	.0800	.0000	.40	3.20	.....	g
792	Sept. 9	V. mark.	V. much white clay	Slight earthy	*	10.00	8.00	.0000	.0030	.0120	.0000	.25	3.70	.....	g
793	Sept. 9	Slight	Slight	Slight veg.	0.0	11.80	7.20	.0000	.0080	.0000	.0000	.73	5.70	.....	g
794	Sept. 9	None	Slight	V. slight	0.0	6.40	4.80	.0000	.0012	.0120	.0000	.60	3.10	.....	g
795	Sept. 11	None	None	Decided veg.	1.90	8.70	2.00	.0028	.0234	.0000	.0002	.11	2.00	.....	b
796	Sept. 9	Slight	Cons. floc.	V. slight	0.0	6.90	2.60	.0000	.0066	.0000	.0000	.08	2.30	.....	g
797	Sept. 11	None	None	Slight veg.	0.15	6.30	2.30	.0000	.0056	.0000	.0000	.12	1.90	.....	g
798	Sept. 11	V. slight	Slight	Marked veg.	0.55	8.80	3.30	.0020	.0230	.0000	.0000	.09	2.20	.....	d
799	Sept. 11	None	None	None	0.0	7.40	4.80	.0000	.0000	.0000	.0000	.10	1.90	.....	g
800	Sept. 11	None	None	None	0.0	5.60	2.20	.0010	.0030	.0150	.0000	.05	1.90	.....	g
801	Sept. 13	None	None	None	0.0	6.10	2.10	.0000	.0000	.0200	.0000	.05	2.00	.....	g
802	Sept. 13	None	None	None	0.0	7.30	3.60	.0000	.0014	.0150	.0002	.15	3.60	.....	g
803	Sept. 15	None	None	Slight	0.0	12.60	10.10	.0000	.0000	.0400	.0000	.50	5.50	.....	g
804	Sept. 15	None	None	None	0 0	6.80	3.30	.0000	.0016	.0200	.0000	.27	2.00	.....	g
805	Sept. 15	Marked	Much iron	V. foul	0.5	11.90	5.90	.0128	.0010	.0000	.0000	.16	2.90	.....	g
806	Sept. 15	None	None	V. slight	0.0	8.80	5.40	.0010	.0028	.0300	.0002	.55	4.10	.....	g
807	Sept. 14	Marked	Much floc. veg.	Decided foul	0.7	11.20	3.50	.0042	.0072	.0000	.0000	.10	3.10	.....	g
808	Sept. 17	V. slight	V. slight	Decided veg.	0.3	11.00	2.30	.0084	.0220	.0150	.0003	.45	1.90	.....	d
809	Sept. 18	None	None	None	0.0	7.60	4.20	.0010	.0022	.0090	.0000	.06	1.90	.....	g
810	Sept. 19	None	None	None	0.0	9.10	5.60	.0000	.0300	.1100	.0000	.36	4.10	.....	g
811	Sept. 19	None	Much floc. veg.	Slight	0.0	20.70	18.70	.0340	.0090	.1200	.0060	2.32	4.70	.....	b
812	Sept. 19	None	None	None	0.0	51.80	33.50	.0100	.0010	.9000	.1660	9.42	14.50	.....	b
813	Sept. 19	None	None	V. slight	0.1	3.40	1.50	.0000	.0010	.0200	.0000	.05	1.50	.....	g
814	Sept. 19	Marked	Much red	Slight	0.15	5.60	4.20	.0000	.0000	.1900	.0001	.40	4.20	.....	g
815	Sept. 20	None	Much floc. veg.	Decided veg.,foul	0 0	6.10	5.10	.0008	.0042	.1000	.0001	.30	2 30	.....	g
816	Sept. 20	Slight	Slight	Foul	0.4	7.20	2.80	.0416	.0098	.0000	.0005	.10	2.30	.....	b
817	Sept. 21	None	None	None	0.0	4.10	1.50	.0000	.0000	.0000	.0000	.10	1.50	.2400	b
818	Sept. 22	None	None	None	0.0	.....	.....	.....	.....	.0120	.0000	.20	3.90	.0380	b
819	Sept. 22	None	None	None	0.0	7.50	5.80	.0000	.0020	.0150	.0000	.10	2.30	.0280	d
820	Sept. 22	None	None	None	0.0	5.30	2.60	.....	.....	.0000	.0000	.07	3.40	.1200	b
821	Sept. 22	None	None	None	0.0	6.10	4.20	.0000	.0010	.1100	.0000	.20	.....	.0280	d
822	Sept. 22	None	None	V. slight	0.1	4.00	1.10	.0000	.0062	.0000	.0000	.11	.60	.....	g
823	Sept. 22	None	Slight	Slight musty	0.1	3.50	.60	.0000	.0112	.0000	.0000	.07	.60	.....	g

* White.

Analyses of Water Supplies.— Continued.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
824	1902. Sept. 22	None	V. slight	Decided veg.	0.15	3.40	.70	.0000	.0090	.0000	.0006	.10	.60	.....	g
825	Sept. 21	None	Slight	None	0.0	.....	.....	.....	.....	.0700	.0000	.35	1.90	.....	g
826	Sept. 22	None	None	None	0.1	6.40	3.60	.0000	.0030	.0000	.0000	.13	3.40	.....	g
827	Sept. 22	V. slight	Slight	Slight	0.3	8.00	2.60	.0022	.0066	.0000	.0003	.18	2.60	.....	g
828	Sept. 22	None	None	Foul	0.0	12.40	7.50	.0000	.0000	.4500	.0002	1.12	5.40	.....	b
829	Sept. 22	None	None	None	0.0	25.80	17.20	.0000	.0024	1.0500	.0002	.87	7.70	.....	b
830	Sept. 22	None	None	None	0.0	30.70	19.40	.0000	.0010	1.6000	.0001	2.27	6.60	.....	b
831	Sept. 22	None	None	None	0.0	17.10	11.30	.0000	.0014	.0250	.0000	.42	5.90	.....	g

WATER SUPPLIES OF CITIES AND TOWNS.

WATER SUPPLIES OF CITIES AND TOWNS IN NEW HAMPSHIRE.

From time to time some investigations have been made by the State Board of Health into the character of certain public water supplies, the results of which have been mentioned, and in some instances quite extensively reported upon in the reports of this board.

Numerous private supplies, also, suspected of being the cause of illness, have been examined, but not before have we been able to present so valuable a mass of facts upon this subject as is included in this report, for the reason that not until the establishment of the State Laboratory of Hygiene were facilities afforded the board for systematic work in this direction.

A description of some of the public water supplies of the state was published in Vol. 14 of the reports of the State Board of Health, but while in some instances that report gives a very complete description of the system, in others they are not described at all, and only in a few cases was a report made upon the character of the water as shown by chemical analysis.

Although a great amount of work has been done at the laboratory in the investigation of our water supplies, and in the analysis of both public and private supplies, as is shown in this report, it has been impossible to analyze all the public supplies of the state. The work will be carried on, however, until this has been accomplished, and such occasional re-examinations will be made as may be deemed necessary to keep a careful watch over the quality of the water.

The large demand for the examination of private supplies, chiefly in cases where the water was suspected of pollution, has consumed so much of the time of the laboratory that not so much work could be done in the examination of public water supplies as was desirable; yet the benefit that has been afforded by the examination of these private supplies, by detecting many waters that were unfit and even dangerous for drinking purposes, has been not only a justification of this particular work, but of great value to many families and communities. As a result of this work, many wells that were polluted to an extent that was dangerous to the consumer have been closed, and other supplies of undoubted quality substituted.

Numerous instances in which an excessive amount of lead has been found, as is shown elsewhere in this report, and other conditions inimical to public health have been reported, and remedies applied in a great majority of cases. Many letters have been written, in addition to the chemists' regular report, pointing out what measures could best be carried out to remove existing dangers. So great has been the demand for examinations of this kind that not infrequently have we been unable to answer all the calls as promptly as we would have liked, yet in no instance has the laboratory declined to make an analysis of a water used for domestic purposes, or of a contemplated supply.

The board has in view investigations which thus far it has been impossible to undertake, among which may be mentioned the examination of the water supplies of our summer resort hotels. Many of these are known to be from sources of undoubted purity, from topographical examinations that have been made by the board from time to time. Nevertheless, analyses of these supplies will eventually be made.

The data given in the following report upon the water supplies of the cities and towns, with the exception of the laboratory work, were obtained through the courtesy of the local boards of health of the state. To get the facts in the briefest possible manner, the following questions were submitted:

STATE OF NEW HAMPSHIRE.

STATE BOARD OF HEALTH.

WATER SUPPLY.

Town .....

Does your town own or operate a public water supply?.....
Are there any private companies supplying water for public use?.....
If so, give corporate name of such.....
.....
When were the works built, and by whom?.....
.....
Is the source of supply a pond, stream, spring, or well?.....
If from a pond, state area, average depth, kind of bottom, etc.....
.....
.....
Give approximate area of watershed; wooded or cleared land; and number of inhabitants thereon.....
.....
.....
Are the shores of the pond frequented by picnic parties, or occupied by summer cottages? .....
.....
If from a stream, give approximate volume of water flowing under normal conditions .....

Does the stream receive any sewage, or waste from manufacturing operations above the intake of the supply?.....
If so, state approximate amount .....
If from springs or wells, give depth, quantity of water flowing, character of soil and subsoil, etc. Are wells bored, driven, or dug?.....
.....
.....
.....
Is the water supplied by gravity, or pumped to standpipe or reservoir?.....
If standpipe, give capacity; if reservoir, give capacity, area, and depth.....
.....
How many miles of distributing mains are in use?.....
What kind of pipes are used for the mains?.....
What kind of pipes for service pipes?.....
What is the average daily consumption in gallons?.....
Has the water ever been analyzed? If so, by whom and when?.....
.....
State percentage of population using public water supply.....
State number of families using the supply described.....
Are there many private wells still in use within the radius reached by the public supply?.....
.....
(Signature) .....
(Postoffice address) .....
(Date) .....
REMARKS.—[Here give any facts or information relating to the subject not incorporated in above answers.]

The substance of the returns made, together with a report on the laboratory work done on both public and private supplies of the respective towns and cities, is given in the following pages.

ACWORTH.—No public water supply. Families get their water from wells or from springs, and lead pipe is used as a rule.

ALBANY.—There is no water supply other than wells and springs. The wells are mostly dug; a few are driven.

ALEXANDRIA.—No public supply. Water is obtained from private wells and springs.

ALLENSTOWN (SUNCOOK).—The Suncook water-works, established in 1877, is supplied from a pond of twenty-five acres and an average depth of fifteen feet. The water runs through five miles of galvanized iron distributing mains, by gravity, to sixty families. Twenty per cent of the population take this water.

Chemical Examination of Water from a Faucet in Pembroke, Supplied by Suncook Water-Works.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
744	1902. Aug. 25	None	None	Slight veg.	1.20	6.20	2.00	.0010	.0190	.0200	.0000	.15	1.90	.....	g

Samples from four private supplies were examined, three of which proved good and one of bad quality. See Nos. 192, 608, 706, and 743 in the table of analyses.

Alstead.—No public supply. A member of the board of health writes: "The town of Alstead is supplied, first, from wells varying from five to possibly twenty feet in depth; say, two thirds use wells, the quality of the water being, on an average, very indifferent. About one third of the people pipe from 'springs,' some by themselves, while others band together in small numbers and so lessen the individual cost. As far as I know, with two exceptions, the running water has never been analyzed, and that was some ten years ago. The analysis of one water supply proved it to be very unsatisfactory, but it is still used. I think people hesitate about having their water supply tested for the reason that if it is condemned they will be uneasy, as they almost always get the water in first and analyze afterward."

Two samples, one from a surface well and the other from a driven well, have been examined. The surface well was found to be unfit for drinking purposes, and the other contaminated sufficiently to render water of doubtful quality, if not positively bad. See Nos. 231 and 428 in table of analyses.

Alton.—No public supply. The Alton & Alton Bay Water-Works Company, established in 1892-93, supplies about one hundred families (90 per cent of the population) with water from a spring, except in dry weather, when it is pumped from Lake Winnipesaukee to a reservoir of 150,000 gallons' capacity. The water flows by gravity from the spring. There are three miles of distributing mains, cast-iron; galvanized iron service pipes.

Chemical Examination of Water from Faucet of Supply of Alton & Alton Bay Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
782	1902. Sept. 6	None	Slight earthy	None	0.0	7.40	3.50	.0000	.0030	.0220	.0000	.27	3.10	.....	g

AMHERST.—No public water supply. There are several private supplies, owned respectively by Elizabeth Nichols, Abby Melendy, H. H. Belden, and Frank Taylor, springs being the source in each case. The soil is very light and sandy, and none of the wells are over six feet deep. The distributing mains, lead, are something like three or four miles in length. About forty families take of this water, but there are also several individual wells within the radius reached by these supplies.

Chemical Examination of Water from Nichols, Belden, and Melendy Springs.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
422	1902. Mar. 3	None	None	None	0.0	.....	.....	.....	.....	.....	.....	....	1.20	.1600	....
423	Mar. 3	None	None	None	0.0	.....	.....	.....	.....	.....	.....	....	1.20	.1100	....
424	Mar. 3	None	None	None	0.0	.....	.....	.....	.....	.....	.....	....	1.40	.0265	....

The water from these supplies is of excellent quality, but dissolves lead readily. There are, however, no cases of lead poisoning recorded from use of the water.

Besides the above, a sample from one well was examined and proved to be unfit for drinking. See No. 425 in the table of analyses.

ANDOVER.—No public supply. Andover Center is supplied with water from springs on the south side of Ragged mountain. The water is collected in reservoirs 12 x 9, 10 x 12, and 15 x 8 feet, and 8 feet deep, and is conducted through lead pipes. Physicians in the town say they have noticed no ill effects from the use of this water. All the piping is

of lead. About thirty-eight families take from this water. The remainder of the town is supplied from individual wells, the water being conducted in nearly every instance through lead pipes to the houses. There have been a number of cases of lead poisoning from individual supplies.

Chemical Examination of Water from Tap of Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
841	1902. Oct. 9	None	Slight	None	0.0	7.00	2.90	.0000	.0000	.0000	.0003	.12	2.20	.....	g

Eight other supplies were examined, of which three were good, one doubtful because of the presence of lead in small quantities, and four were bad. Of the four bad waters two were condemned because of the presence of lead. For results see Nos. 25, 278, 399, 446, 451, 477, 597, 655.

ANTRIM.—A water supply was installed by the town in 1893, the source being a pond of about sixteen acres in area and of an average depth of sixteen feet. The water flows by gravity a distance of eight miles through wood mains, and the service pipes also are of wood. About one half the population, 175 families, take this water.

Chemical Examination of Water from Public Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
95	1901. July 30	None	Slight floc.	Strong veg.	0.4	3.40	.80	.0000	.0242	.0000	.0000	.11	.....	.....	...
96	July 30	None	Much floc	De. veg. & musty	1.1	4.30	2.20	.0036	.0180	.0000	.0000	.12	.....	.....	*
97	July 30	None	Slight	Decided musty	0.3	4.50	1.80	.0074	.0150	.0080	.0000	.12	.....	.....	...
98	July 30	None	Slight	Decided aromat.	0.4	3.20	1.20	.0028	.0184	0000	.0000	.13	.....	.....	...
177	Sept. 20	None	Slight	Faint veg.	0.25	3.50	.60	.0028	.0180	.0000	.0000	.09	.....	.....	...
178	Sept. 20	None	Slight	Faint veg.	0.25	4.40	.90	.0026	.0180	.0000	.0000	.09	.....	.....	...

* Iron, .2360.

All the samples were collected from faucets with the exception of No. 95, which was taken directly from the pond. At the time the first four samples were examined the water was in a very bad condition. The color was very high, the odor very offensive, and the organic matter excessive. This was caused by flowing a meadow which had not been stripped of turf and humus. Samples taken two months later showed a marked inprovement in the quality of the water. Of the four other samples examined three were of excellent quality and one was badly polluted.

Samples from four private supplies, three wells, and one spring have been examined. One well was pronounced unfit for use; the others good water. See Nos. 40, 267, 303, 304, in table of analyses.

ASHLAND.—The town installed a water supply in 1894, from a pond about half a mile square; bottom mostly gravel. It is a gravity system; about nine miles of distributing mains, cast iron; service pipes, galvanized iron. About 200 faucets, representing 90 per cent of the population, have been put in. There are not many individual wells in the locality.

Chemical Examination of Water from Tap of Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albaminoid.	Nitrates.	Nitrites.				
840	1902. Oct. 9	None	None	Veg.	0.25	6.50	1.00	.0000	.0064	.0000	.0000	.07	1.00	.....	g

A sample from one private supply has been analyzed and pronounced unfit to use. See No. 39 in table of analyses.

ATKINSON.—No public supply. Water is obtained from private wells.

AUBURN.—No public water supply. There is one private supply from which seven families are furnished, and one public watering trough for the town.

But one supply was examined, and that was found to be pure. For result see No. 454.

BARNSTEAD.—No public supply. Water is obtained almost wholly from wells, which have been dug from one to one hundred and thirty-five years.

The two supplies examined were found to be badly polluted, and unfit for drinking. For results see Nos. 21 and 752.

BARRINGTON.—No public or private water-works.

Three samples from private wells were examined, of which one was good, one bad, and one doubtful. For results see Nos. 559, 560, and 814 in the table of analyses.

BARTLETT.—The public water supply, owned by the village precinct, was installed about the year 1888, by the Bartlett Water Company. The source is a stream having a watershed of two square miles, wooded land, no inhabitants. It is a gravity. The distributing mains, and a majority of the service pipes, are of wrought iron. About one hundred families, the entire population, are consumers of this water. There is one private well in the locality.

Chemical Examination of Water from Tap of Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
880	190 2. Oct. 21	None	None	V. slight veg.	0.1	4.90	.80	.0000	.0020	.0000	.0000	.07	.60	.....	g

BATH.—No public supply. The Bath Aqueduct Company, private, about 1877 instituted a water supply from a spring excavated to a depth of six feet and twelve feet in diameter. It fills a two-inch pipe without slowing down. The iron distributing main is two miles long; service pipe is of iron. Fifteen families, 30 per cent of the population, are takers. A part of the village is supplied from other springs, five or six families taking from the same spring. There are no individual wells within the radius of these supplies.

Chemical Examination of Water from Faucet of Bath Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
802	1902. Sept. 13	None	None	None	0.0	7.30	3.60	.0000	.0014	.0150	.0002	.15	3.60	.....	g

BEDFORD.—No public supply. Water is obtained wholly from private wells and aqueducts on the farms. There is no pond in town from which to obtain water.

BELMONT.—The Belmont water-works, owned by the town, were installed in 1893. Water is obtained from wells, supplemented by a stream in dry seasons. One well was bored two hundred feet deep, and two wells were dug. The water is pumped to a reservoir, covered, 120 x 20 feet, and 7 feet deep, and having a capacity of about 100,000 gallons. There are about four miles of distributing mains, of wood, while the service pipes are galvanized iron. One hundred and ten families take from this supply. There is a pumping station for use in dry seasons, by which water is pumped from a stream to the reservoir. There is also a private supply in the town.

Chemical Examination of Water from Tap of Belmont Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
864	1902. Oct. 15	None	None	None	0.0	5.60	3.00	.0000	.0030	.0000	.0000	.12	3.00	.....	g

The water from five other supplies was examined, and one supply proved to be bad, one doubtful, and three good. For results see Nos. 121, 299, 300, 382, and 397 in table of analyses.

BENNINGTON.—No public supply. The Bennington Water-Works Company, a private company, in 1900 installed a system supplied from springs, with a supplementary supply from a stream. The main supply is from springs and flows by gravity to a reservoir of about 1,500,000 gallons' capacity. There is an abundant supply. There are about four miles of distributing mains; 12-inch pipe, one fourth mile; 10-inch pipe, one mile and a fourth; 6-inch, one mile; and the remainder 2½ and 1½-inch. The small pipe is part of a system put in in 1887, and now attached to larger pipe. Can throw six good fire streams. Service pipe is ¾-inch galvanized iron. About ninety families, 60 per cent of the population, take this water. There are about fifty or sixty wells within the radius.

Chemical Examination of Water from a Faucet of the Bennington Water-Works Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
751	1902. Aug. 27	None	V. Slight	None	0.15	6.50	2.80	.0000	.0000	.0000	.0000	.10	1.50	.....	g

Two private supplies have been examined. Both were found to be good water, but one contained lead. See Nos. 202 and 344 in table of analyses.

BENTON.—No public supply. Water is obtained from springs, through lead pipes and logs, and from wells.

BERLIN.—No public supply. There are two private supplies, owned and operated by one company,—the Berlin water-works, built in 1892-93, and the Cold Water Spring Company, installed in 1898. The source is a stream and springs. The springs were excavated and made into a reservoir from rocky and ledgy land. Water flows by gravity. The stream is dammed so as to form a sort of a reservoir. There are twelve miles of distributing mains in the Berlin water-works system, cast iron; service pipes, galvanized iron. For a period of about six weeks each year, the latter supply has to be supplemented by water pumped from Androscoggin river, above the city limits.

Chemical Examination of Water from Tap of Berlin Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
843	1902. Oct. 9	None	None	V. slight	0.75	6.50	1.40	.0000	.0112	.0000	.0000	.05	1.40	.....	g

One other supply was examined and found to be of very bad quality. For result see No. 473.

BETHLEHEM.—No public supply. The Crystal Springs Water Company, a private corporation organized in 1878, gets its supply from springs, by gravity. Its reservoir has a capacity of about one thousand gallons. There are about twelve miles of iron distributing mains. Eighty-three families, or about 95 per cent of the population, are takers of this water.

Chemical Examination of Water Supplied by the Crystal Springs Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
347	1902. Jan. 3	Slight	Slight veg. and min.	Earthy veg.	0.2	5.30	3.80	.0074	.0076	.0400	.0000	.06	1.60	.....	g

BOSCAWEN.—Water is from the public supply, Penacook & Boscawen Water Precinct, constructed in 1892. The source is a pond of 340 acres; greatest depth, thirty-six feet; soil, largely gravel. The watershed is nearly seven square miles, both wooded and cleared. There are five or six houses on the shores of the pond. The water flows by gravity, through about thirteen miles of wooden mains, size from two to twelve inches. Service pipes are iron. About 250 families, or 95 per cent of the population, are supplied from this source.

Chemical Examination of Water from Faucet of Penacook & Boscawen Water Precinct at Penacook.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
789	1902. Sept. 9	None	None	Slight veg.	0.45	10.10	1.80	.0000	.0142	.0000	.0000	.11	1.50	.....	g

Four private supplies have been examined, of which two proved to be excellent water, and two contained lead in an amount that rendered them dangerous to use. See Nos. 393, 452, 535, and 589 in the table of analyses.

Bow.—No public water supply. Wells and springs are the principal sources of supply. Of the four supplies examined, two were good, one was polluted by sewage, and one contained a dangerous amount of lead. For results see Nos. 55, 72, 73, and 623.

Bradford.—No public or private system of water-works.

Samples from four private supplies have been examined, of which two were reported suitable for drinking purposes, one suspicious, and one wholly unfit for drinking. For detailed results see Nos. 111, 134, 289, and 305 in table of analyses.

Brentwood.—No water supply other than individual wells and springs.

Bridgewater.—No public supply. Wells and springs are the only sources from which water is obtained.

Bristol.—No public supply. The Bristol Aqueduct Company, a private corporation, have furnished water from Newfound lake since about 1887. The lake has an area of nine square miles; average depth about sixty-five feet. The water flows by gravity. There are six miles of mains, cement lined mostly; service pipes iron, and some lead. About 60 per cent of the population, 250 families, are takers. There are probably fifty wells and private springs within the circuit of this supply.

Chemical Examination of Water from a Faucet of the Bristol Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
747	1902. Aug. 26	None	V. slight	Slight veg.	0.15	3.90	1.50	.0016	.0050	.0000	.0000	.06	.40	.....	g

Brookfield.—No public supply. All families in town are supplied with water from wells or springs.

Brookline.—No public supply. Water is obtained from private wells and springs.

Chemical Examination of Water from Public Fountain Supplied by a Well.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
327	1901. Dec. 10	None	None	Slight foul	0.0	9.30	7.00	.0000	0076	.1250	.0002	.80	2.00	.....	g

CAMPTON.—There is no public water supply. The town is supplied by private wells. In some cases two or more families take water from the same well.

Chemical Examination of Water from Pemigewasset River at Campton.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
234	1901. Oct. 28	None	None	Faint veg.	0.4	3.40	1.60	.0016	.0094	.0100	.0000	.06	1.60	.....	*g

* Sulfites, .0040.

On complaint of residents of Campton that paper-mill waste was polluting the river, analysis of the water was made and the results showed that the contamination was very slight and not of an injurious nature.

CANDIA.—No public supply. In 1894 or 1895, Mr. John A. Holt, shoe manufacturer at East Candia, introduced a water supply from a well bored one hundred feet deep. The well is on land elevated above surrounding country, and cannot be pumped dry by steam pump. The water is pumped by windmill to a tank of 7,000 gallons' capacity, elevated forty-five feet. The distributing main, 3-inch iron, is about one half mile in length; service pipes are ¾-inch iron. Thirteen families and the shoe-shop are supplied from this source. There are quite a number of private wells in the locality.

Chemical Examination of Water from Supply of John A. Holt, East Candia.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
869	1902. Oct. 16	None	None	None	0.0	14.10	10.60	.0000	.0000	.4800	.0000	1.45	4.70	.....	g

CANAAN.—No public supply. A private supply was introduced by the Crystal Lake Water Company in 1891. The supply is from Hart's pond, having an area of two hundred acres, an average depth of eighteen feet, and a sandy bottom. The watershed is about a thousand acres, partly wooded and partly cleared land, having about fifty inhabitants. The pond is fed by springs. It is a gravity system. The distributing mains are about two miles in extent, and these as well as the service pipes are of iron. Fifty families are supplied from this source. There are about a dozen private wells in the locality, and about a dozen springs from which water is obtained.

Chemical Examination of Water from Crystal Lake Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
868	1902. Oct. 16	Marked	Much floc.	Decided veg.	0.2	5.50	2.10	.0000	.0168	.0000	.0000	.07	2.00	.....	...

The water from seven of these supplies was examined and three were reported good, two were doubtful, and two were bad. The two doubtful waters were so reported because they contained small amounts of lead. For results see Nos. 219, 220, 230, 363, 479, 480, 715.

CANTERBURY.—There is no public or private water supply for the town. Most of the dwellings are supplied by individual wells.

Of the four supplies examined, two were good and two unfit to use as supplies for drinking and domestic purposes. For results see Nos. 504, 610, 738, and 739.

CARROLL.—No public water supply.

CENTER HARBOR.—No public or private system of water-works. The supply of the village is largely from springs, the water being conveyed through iron pipes. The Senter House pumps water from Lake Winnipesaukee for washing and bathroom purposes.

Three samples from private supplies have been examined: Two, from wells, were pronounced good; the other, from a spring, was found to be excellent water, but contained a slight amount of lead. See Nos. 447, 598, and 599 in table of analyses.

CHARLESTOWN.—No public water supply.

CHATHAM.—No public supply. The water supply is mostly from dug wells, a few springs, and a few places are supplied from brooks and comes through lead pipe. Some iron pipe is used.

CHESTER.—No general public water supply. There are several watering places for horses and cattle supplied by springs, and the town owns a well at one of the schoolhouses.

One sample from a well has been examined, and was classed as unfit for drinking. See No. 684 in the table of analyses.

CHESTERFIELD.—No public supply. Water is obtained chiefly from springs and wells.

CHICHESTER.—No public supply. The water used for drinking purposes is obtained chiefly from wells, dug and stoned. In some instances water is pumped by windmill to tanks or reserviors, and is used for watering stock, or in case of fire. Four families take water from the river, but not to drink. Some water is also brought from the hills through lead or iron pipes.

Four samples from private sources have been examined, three of which were pronounced good and one bad. See Nos. 6, 505, 506, and 514 in the table of analyses.

CLAREMONT.—The town owns a water supply from a stream and a system of wells. The wells are twelve in number, dug twelve feet deep and covered with five feet of earth, so the depth of the wells is seven feet; they are three feet in diameter after being stoned. The amount of water is very abundant, and is pumped to the supply reservoir. Water from the stream is held in three reservoirs. There are about fifteen miles of distributing mains. Cement pipes were first used, but now all are iron; service pipes are galvanized iron. At least 1,000 families, fully 75 per

cent of the population, take this water. There are not many private wells in the locality.

Chemical Examination of Water from Town Supply Reservoir.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
791	1902. Sept. 11	None	None	Slight veg.	0.15	6.30	2.30	.0000	.0056	.0000	.0000	.12	1.90	.....	g

Besides the public supply, there are two private systems of water-works in Claremont: one, the Tyler water-works, was built in 1870, the source being springs. The springs are excavated all about a reservoir, into which the water runs. There are also springs in the bottom of the reservoir, which is about five acres in area; eight acres fenced with wire. The distributing mains, lead, are about ten miles in length, and the service pipes, also, are of lead. About 250 families are consumers, and each family is entitled to sixty gallons of water per day.

The other private system, known as the Grannis water-works, built about 1892 and owned and operated by Herman Holt, Esq., is also supplied by springs. There are two small reservoirs from which this water is taken: one some thirty feet in diameter, and about three feet deep on an average; the other some seventy-five feet in diameter, and of an average depth of about three feet. Both bottoms are blue clay hardpan. These reservoirs are perhaps thirty rods apart; are at the top of a precipitous bank covered with trees, at the foot of which runs a large brook known as Red Water brook, and the small area of land lying above the reservoirs, from which there might be some slight surface drainage at the time of melting snows in spring, is not occupied either as pasture or tillage. No animals enter upon it; no brooks enter either reservoir; no low land, no swamp, no places at which water can collect at any season of the year and flow or drain into these reservoirs lie above them. The springs supplying these two reservoirs come from a clay or hardpan band. Above and beyond this band is sandy soil, in which small pine trees are standing. Both reservoirs are surrounded by trees, mostly pine, and both are at the extreme upper edge of woodland. Each reservoir is but a few feet from the springs by which it is supplied. The water flows by gravity, and the pipe from the upper reservoir enters the pipe at the lower reser-

voir. There are about two miles of distributing mains, cast iron; service pipes mostly iron, but some lead. About twenty families, one hotel, one school building, and one mill (for drinking purposes) are consumers of this water.

Chemical Examination of Water from Faucet of Hotel, Supplied by Grannis Water-Works. *

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
236	1901. Oct. 28	None	None	None	0.0	7.10	4.40	.0028	.0044	.0200	.0003	.07	.....	.....	g
237	Oct. 28	None	None	None	0.0	9.20	5.30	.0028	0054	.0200	.0003	.07	.....	.....	g
241	Oct. 31	None	None	None	0.0	7.80	5.70	.0010	.0040	.0200	0004	.07	2.40	.....	g

* Sample 237 was from Farmington faucet.

Clarksville.—No public supply. Every dwelling in town is furnished with spring or well water.

Concord.—The Concord water-works, owned and operated by the city, were installed in 1871-72; extended to Penacook and St. Paul's School in 1882; high-service extension in 1891. The source of the supply is Penacook lake, with an area at high water of 337 acres; depth unknown; bottom gravelly. The watershed, about 3⅛ square miles, is partly wooded and partly cleared. Outside of cottagers, a canvass showed seventeen inhabitants to the square mile. The shores are frequented by picnic parties, and are occupied by summer cottages. The water board controls about eight tenths of the shore. For the low service the water flows by gravity; for high service water is pumped to reservoir having a capacity of 2,000,000 gallons, and a depth of twenty feet from top of embankment, and fifteen feet from high-water mark; diameter at top of embankment, 195 feet, 8 inches. On January 1, 1902, there were 61.20 miles of distributing mains, cast iron and cement lined; service pipes, cement lined. About 17,000 persons are consumers of this water. There are a few private wells in water precinct.

Chemical Examination of Water from City Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
1	May 22	V. slight	Slight	Decided veg	0.0	2.90	1.80	.0015	.0163	.0048	.0000	.13	.....	.....	g
2	May 22	V. slight	Slight	Faint veg.	0.0	.....	.....	.0013	.0122	.0048	.0000	.12	.....	.....	g
3	May 22	Slight	Consid.	Decided veg.	0.0	.....	.....	.0013	.0149	.0048	.0000	.12	.....	.....	g
4	May 23	Slight	Consid.	Decided veg.	0.0	2.50	1.20	.0014	.0137	.0050	.0000	.12	.....	.....	g
107	Aug. 6	None	None	Decided veg.	0.12	3.30	.90	.0000	.0154	.0000	.0000	.11	.....	.....	g
113	Aug. 12	Slight	Slight floc.	Decided veg.	0.1	4.00	1.40	.0014	.0156	.0000	.0000	.10	.....	.....	g
	1902.														
357	Jan. 11	None	None	Veg.	0.1	3.20	1.20	.0030	.0138	.0000	.0000	.14	1.10	.....	g
398	Feb. 10	V. slight	V. slight	Veg.	0.12	3.70	1.90	.0044	.0136	.0000	.0000	.12	.90	.....	g
591	June 13	V. slight	V. slight	Decided veg.	0.15	5.30	1.50	.0016	.0146	.0000	.0000	.11	.70	.....	g
592	June 13	V. slight	Slight	Decided veg.	0.1	6.20	1.60	.0000	.0124	.0000	.0000	.11	.70	.....	g
593	June 13	V. slight	V. slight	Slight	0.15	5.50	2.10	.0006	.0072	.0000	.0000	.11	.70	.....	g
594	June 13	V. slight	V. slight	Veg.	0.15	6.10	1.70	.0006	.0126	.0000	.0000	.11	.70	.....	g
595	June 13	V. slight	V. slight	Veg.	0.15	6.70	1.70	.0006	.0108	.0000	.0000	.12	.70	.....	g
596	June 13	None	None	Veg.	0.15	6.20	1.60	.0000	.0112	.0000	.0000	.11	.70	.....	g
775	Sept. 4	None	None	Decided veg.	0.1	4.30	1.50	.0000	.0102	.0000	.0000	.12	1.50	.....	g

Chemical Examination of Water from Well at Penacook Lake Park.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
119	Aug. 10	None	None	None	0.0	6.10	4.80	.0000	.0000	.0000	.0000	.24	1.90	.....	g

Chemical Examination of Water from Well at White's Park.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
120	1901. Aug. 16	None	Slight floc.	Faint veg.	0.0	14.00	8.30	.0000	.0010	.7000	.0000	1.13	3.05	.....	d

The water from twenty-two other supplies was examined. Eleven supplies were of good quality, six were bad, and five doubtful. For results see Nos. 23, 24, 38, 71, 91, 93, 117, 170, 179, 194, 301, 394, 419, 489, 529, 574, 590, 613, 646, 653, 769, 808.

Conway Village.—No public supply. The Conway Aqueduct Company, under local management, supplies this village with water from a system of natural springs, about two and a half miles from its center. The supply is not affected by drouth. The reservoir, which is oval in shape, the greatest dimensions being 100 x 50 feet and 5 feet deep, is fitted with a rinse pipe, and by which the reservoir is emptied once a year and thoroughly cleaned. There are about three miles of cast-iron (coated inside and out) service mains in the village, and two and a half miles to the reservoir. Galvanized iron service pipes are used. The average daily consumption, by 120 families, is from 2,000 to 3,500 gallons, varying with the season. This water was analyzed in 1890, and pronounced excellent. There are comparatively few private wells in the village, possibly twenty-five or thirty.

Samples from eleven private supplies have been examined, five of which were classed as good, and six of bad or doubtful quality. See Nos. 292, 353, 352, 569, 568, 567, 552, 551, 550, 664, and 289 in the table of analyses.

Cornish.—No public water supply. All the families of this town depend upon wells, or water taken from springs through lead pipe, each family having a separate supply.

Croydon.—No public supply. One private supply is from a spring, the water being brought one half mile through lead pipe, from which five families are furnished. Most of the water is from private wells.

Dalton.—No public supply. Water is obtained from individual springs.

DANBURY.—No public or private system of water-works.

A sample from one spring has been examined, and was pronounced good. See No. 364 in the table of analyses.

DANVILLE.—No public supply. The water supply of Danville is, in nearly every case, from a well near the house or underneath it.

DEERING.—No public water supply.

DERRY.—No public supply. In 1890 Boston contractors built the Derry water-works, consisting of about forty wells driven to a depth of fifty feet. The water is pumped to a standpipe of 180,000 gallons' capacity; average daily consumption of the 350 families supplied, 100,000 gallons. There are about eight miles of distributing mains, of cast-iron pipe; galvanized iron service pipes.

Chemical Examination of Water from Faucet of Derry Water-Works Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
794	1902. Sept. 4	None	Slight	V. slight	0 0	6.40	4.80	.0000	.0012	.0120	.0000	.60	3.10	.....	g

DORCHESTER.—The water used in town is from private wells and springs.

DOVER.—A public water supply was installed by the city of Dover in 1888. The area of the pond from which the supply is taken is, when full, 78¾ acres; when drawn down six feet, 69½ acres. There are no measurable streams of water flowing into the pond, it being fed mainly from underground sources. The water is pumped to a reservoir of a capacity of 2,085,452 gallons when at a height of fourteen feet. The area of high-water surface is 27,172 square feet; depth of basin in center, 19 feet. There are twenty-five miles of cast-iron distributing mains; service pipes, wrought iron, cement lined. Two thousand nine hundred families, 85 per cent of the population, are takers of this water, and the average daily consumption in 1901 was 658,238 gallons.

Chemical Analysis of City Water Supply of Dover.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
246	1901. Nov. 4	None	None	Faint	0.0	5.50	2.40	.0010	.0080	.0000	.0000	.19	.....	.....	g

Six private supplies have been examined; four from wells, two from springs. Of these, five were pronounced good, or permissible for drinking, while one was bad. See Nos. 141, 430, 526, 587, 625, 639 in table of analyses.

DUBLIN.—This town has no water system, the supply being mostly from individual wells and springs, and from streams and ponds through private pipes, iron or lead.

Four supplies have been analyzed at the State Laboratory of Hygiene, and all found to be of excellent quality. For results in detail see Nos. 83, 110, 464, and 556 in the table of analyses appended.

DUMMER.—No public supply. Water is obtained chiefly from springs, wells, and aqueducts.

DUNBARTON.—No public supply. Water is obtained from springs and wells.

Two supplies examined were found to be of good quality. For results see Nos. 790 and 791.

DURHAM.—No public supply. In 1894 a private supply was installed, the water being obtained from several springs and wells, which are piped to a central, and from there pumped to a standpipe of 20,000 gallons' capacity. But little care was taken to exclude surface water when the system was introduced, and the wash and sewage from several houses entered the wells at certain periods of the year. Analyses of the water from the various sources showed a variable composition and the presence of sewage in a partially oxidized condition. In 1900 typhoid fever appeared in several families who used the water. The wells were thoroughly cleaned, drainage and sewage excluded, and at the present time the quality of the water is improved, and the supply is considered quite suitable for drinking. The wells are dug from ten to twenty-five feet,

through clay. Two miles and a half of iron mains are laid; service pipes of lead.

Chemical Examination of Water from Faucet of Supply of C. H. Pettee.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
784	1902. Sept. 8	None	None	None	0.0	15.20	9.50	.0012	.0028	.3500	.0003	.25	5.50	.....	..

Samples from three private supplies have been examined; one good, one bad, and one of doubtful quality. See Nos. 249, 491, and 674 in the table of analyses.

East Kingston.—No public water supply. There is one watering-trough, from which five families are supplied. Iron and lead pipe are used.

Easton.—No public supply. Water is obtained from individual wells and springs.

Eaton.—No public water supply.

Effingham.—No public supply. Water is obtained mostly from wells; a few springs; lead and iron pipes.

Sample of water from one well has been examined, and was pronounced unfit for drinking. See No. 245 in table of analyses.

Ellsworth.—No public supply. Water is obtained wholly from private springs and wells.

Enfield.—No public water supply. Water-works are now in process of construction. Forty-five thousand dollars voted for the purpose.

Epping.—No water supply other than individual wells and springs.

Three supplies have been examined, and all were found to be suitable for drinking. See Nos. 112, 768, and 831 in the table of analyses.

Epsom.—No public water supply operated by town or private company.

Three samples of water from this town have been analyzed at the State Laboratory of Hygiene. Of these, one was pronounced potable; one, containing a large amount of lead, was condemned; and one, although apparently good, was so undesirably located that its abandonment was advised. For results see Nos. 106, 355, and 755 of the table of analyses.

ERROL.—No public supply. Samples of water from several suspected wells and springs were analyzed at the State Laboratory of Hygiene, at Concord, in the fall of 1901, and in those cases pronounced to be unfit for drinking purposes the wells have been abandoned for drinking purposes.

Of the eight supplies examined, five were badly polluted and three were found suitable for drinking. For results see Nos. 254, 255, 256, 257, 258, 259, 260, 261.

EXETER.—No public supply. The Exeter water-works, owned by a private company, were installed in 1886. The source of the supply is an artificial pond fed by springs and brook; area, twenty acres; average depth, eight feet; clay bottom. The water is pumped to a standpipe of 211,000 gallons' capacity. There are fourteen miles of cast-iron distributing mains; galvanized iron service pipes. Eight hundred families, 90 per cent of the population, take of this supply. There are no private wells within the radius of this supply.

Chemical Examination of Water from Faucet of Supply of Exeter Water-Works.

Number.	Date of collection.	ARANCE.				RESIDUE ON EVAPO'N		AMMONIA		NITROGEN AS		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
749	1902. Aug. 26	V. slight	Decided red. floc.	Marked veg.	0.5	7.80	2.80	.0000	.0202	.0000	.0000	.37	2.0	8	..

Numerous examinations of private wells have been made during the past year, and nearly all have been found to be badly contaminated by sewage. The water of certain wells has an abnormally high chlorine content, probably due to the fact that the wells enter a stratum permeated with salt from Exeter river. See Nos. 32, 62, 63, 64, 149, 150, 165, 193, 741, and 742 in table of analyses.

FARMINGTON.—The town owns and operates a water supply from two springs twelve feet deep. The water is distributed from a reservoir through four miles of cast iron, and cement-lined mains; service pipes of wrought iron and galvanized iron. One hundred and seventy families, one third of the population, are supplied from this source. There are not many individual wells in the locality.

Chemical Examination of Water from Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
853	1902. Oct. 10	None	Slight	V. slight	0.0	5.90	3.00	.0000	.0020	.0200	.0000	.45	3.00	.....	g

FITZWILLIAM.—No public supply. The water used throughout the town comes from wells or from springs, many families in the village having running water from springs the entire year.

The two supplies examined were found to be badly polluted. For results see Nos. 476 and 760.

FRANCESTOWN.—No public supply. There is a private supply from which twenty-four families take. The source is a spring, dug 8 x 10 feet, and 10 feet deep, through rocky soil and hardpan. The reservoir is covered. The water flows by gravity half a mile, through iron main, and iron service pipes. There are also many private wells in the locality.

Chemical Examination of Water from Spring Reservoir.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
783	1902. Sept. 6	None	None	V. slight	0.0	8.50	4.00	.0000	.0000	.3000	.0000	.10	2.70	.....	g

FRANCONIA.—No public supply. A private company, known as the Franconia Water Supply Company, in 1888 or 1889, introduced a water

supply from a spring a mile and a half distant. The water flows by gravity through iron mains and lead service pipes. The volume of water is about 10,000 gallons in twenty-four hours. About three fourths of the village population use the water.

Chemical Examination of Water of the Franconia Water Supply Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
387	1902. Feb. 1	None	Floc.	Earthy veg.	0.2	5.90	1.30	.0000	.0086	.0210	.0000	.10	1.30	.....	g

FRANKLIN.—The Franklin water-works, owned by the city, were built in 1891. The source is springs, which are about six feet deep, dug and bricked. There is a covered reservoir about twenty feet deep. Cast-iron pipe is used for the mains, of which there are about fifteen miles; lead, galvanized iron, and cement-lined iron pipes are used for service. The average daily consumption is 200,000 gallons. Seven hundred and fifty-two families are supplied, about three fourths of the entire population of the city. There are not many private wells in the locality.

Chemical Examination of Water from Faucets of Franklin Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
78	1901. July 24	None	None	None	0.0	3.90	2.70	.0036	.0052	.0200	.0000	.14	....	.0100	g
337	Dec. 20	None	None	Slight veg.	0.05	3.40	2.10	.0008	0034	.0400	.0000	.18	.8	.....	g
338	Dec. 20	None	None	Slight veg.	0.05	4.00	2.40	.0014	.0050	.0220	.0000	.16	.8	.....	*g
339	Dec. 20	None	None	Slight veg.	0.05	4.40	1.40	.0026	.0054	.0760	.0000	.30	.8	.....	†g
804	1902. Sept. 15	None	None	None	0.0	6.50	3.30	.0000	.0016	.0200	.0000	.27	2.0	.....	g

*Sample taken from tap at pumping station.
†Sample taken from reservoir of sulfite spring.

In addition to the examination of the public water supply of Franklin, twenty-one private supplies have been analyzed. Ten of these sup-

plies were found to be of good quality; eight were bad; and three others were of doubtful quality. Of the eight supplies pronounced bad, three were so declared because lead was present in large quantities. For detailed results see Nos. 70, 76, 77, 133, 155, 204, 218, 279, 307, 315, 389, 411, 434, 453, 467, 474, 577, 584, 663, 748, and 785.

FREEDOM.—No public supply. Some three fourths of the families in town are supplied with water from springs through iron and lead pipes. A few wells are still used.

FREMONT.—No public or private water system.

GORHAM.—No public supply. The Alpine Aqueduct Company, organized in 1873, furnishes water to 160 families, one half the population. They have nineteen springs, three to seven feet deep, stoned and covered. The capacity is 10,000 gallons. The distributing mains, of cast iron and galvanized iron, are four miles in length; service pipes of iron.

Chemical Examination of Water from a Faucet of the Alpine Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
799	1902. Sept. 11	None	None	None	0.0	7.40	4.80	.0000	.0000	.0000	.0000	.10	1.90	.....	g

GILFORD.—No public supply. Water is obtained from individual wells and springs.

GILMANTON.—No public water supply.

GILSUM.—The only water-works in town are where two or three families unite in taking water from springs by laying a pipe. Wells are, however, chiefly used.

GOFFSTOWN.—The present system was built in 1891 by the Goffstown Fire Precinct, Goffstown Village. The reservoir from which the water supply comes is situated between the Uncanoonuc mountains and is surrounded by woodland. The reservoir is fed by springs in the bottom of the reservoir; by a brook, fed by springs flowing from the northeastern

slope of the north mountain; and from a swamp flowing into the brook near the mouth of the reservoir. The volume of water entering the reservoir daily, chiefly from the springs, is about 73,000 gallons, the full capacity being 2,250,000 gallons; area, 8,987 square yards; depth, about 18 feet. The water flows by gravity through five miles of cast-iron mains; service pipes are galvanized iron. The average daily consumption is possibly 75,000 to 100,000 gallons. There are 236 service faucets, representing about 99 per cent of the population. There are a very few private wells in the district reached by the public supply. The water supplied is of high color, and contains very much organic matter. There have been epidemics of bowel troubles at various times, which have been attributed to the condition of the water. The peculiar quality of the water is attributed to the fact that in the spring and during the heavy rains in the fall and at other times when it is wet or rainy the water flows from the swamp of one hundred acres into the reservoir. The precinct is planning to buy the swamp so as to control the flow of water from it. This is very desirable, and when accomplished will greatly improve the quality of the water. Parts of the town outside the precinct are supplied by wells and springs.

Chemical Examination of Water from Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
201	1901. Oct. 10	None	Floc. veg.	Decided veg.	1.40	5.60	2.20	.0042	.0276	.0000	.0002	.17	.....	.....	..
795	1902. Sept. 11	None	None	Decided veg.	1.90	8.70	2.00	.0028	.0234	.0000	.0002	.11	2.00	.....	..

GOSHEN.—No public supply. Water is obtained from wells, eight to twenty feet deep, through loam, gravel, clay, and sand.

Of the two supplies examined, one contained so much lead that it was unfit for use, and the other was of doubtful quality. For results see Nos. 502 and 586.

GRAFTON.—No public supply. All the water is obtained from individual wells and springs.

Four samples of water from this town have been examined at the State Laboratory of Hygiene. Of these two were potable, one was bad, and one,

containing a slight amount of lead, was pronounced of doubtful quality. See Nos. 118, 175, 294, and 296 of the table of analyses.

GRANTHAM.—No public supply. Water is obtained entirely from private wells and springs.

Five supplies from this town have been examined; three were found to be badly polluted, while two were of acceptable quality. For results see Nos. 341, 342, 343, 666, and 690 in the table of analyses.

GREENFIELD.—There is no public water supply. Water is obtained from wells dug four or five feet deep, in sandy soil, and flows by gravity one eighth of a mile through lead pipe. In two instances two or three families have shared the expense and have the same supply. One supply was declared dangerous by the State Laboratory of Hygiene.

Five samples have been examined and four found to be suitable supplies. One supply contained so much lead as to be unsafe. For results see Nos. 383, 384, 421, 437, and 753.

GREENLAND.—No public supply.

Nine private supplies have been examined and, with one exception, all found to be of good quality. For results see Nos. 167, 168, 379, 380, 381, 392, 676, 704, and 705.

GREENVILLE.—The town owns and operates a small water supply in the form of an artesian well 425 feet deep, ending in solid rock, and most of the distance below 125 feet in solid rock. The water is pumped to a brick reservoir of 20,000 gallons' capacity. The distributing main is of wood, from one fourth to one third of a mile in length; service pipes are of galvanized iron. Thirteen or fourteen families are supplied from this source, while a large number of others get their drinking water from the fountain in the public square, supplied from the artesian well. There are many individual wells.

Chemical Examination of Water from Faucet of Artesian Well Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
753	1902. Aug. 27	None	None	None	0.0	12.40	8.70	.0000	.0000	.0200	.0000	.12	3.90	.....	g

Four wells and one spring have been analyzed. Three wells and the spring were pronounced good; the other well, bad. See Nos. 26, 285, 462, 516, and 648 in the table of analyses.

GROTON.—No public supply. Water is obtained from individual springs and wells.

GROVETON.—The Northumberland water-works, owned by the village of Groveton, were constructed in 1895-96. Water is taken from a stream fed by springs, and flows by gravity to a reservoir of 600,000 gallons' capacity. There are about five miles of distributing mains, cast iron; service pipes of galvanized iron. Ninety-seven per cent of the population are supplied from this source. There are three or four wells within the radius.

Chemical Examination of Water from a Faucet of the Northumberland Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
765	1902. Sept. 1	None	None	None	0.0	5.50	3.60	.0000	.0024	.0300	.0000	.05	1.80	.....	g

One private well has been examined and was pronounced bad. See No. 336 in table of analyses.

HAMPSTEAD.—No public supply. A member of the board of health writes: "Although we have no water-works, we could have at small expense, as Wash pond is almost pure and is fed wholly by springs. A hill to the south would give power enough for the whole village."

But one sample was examined, and that was found to be badly polluted. For results see No. 459.

HAMPTON.—The water supply of this town is from individual wells and springs, as it has been for the past two hundred years and more. A water company has been formed recently, and it is expected that a good and sufficient supply of water will be supplied in the near future.

Three samples of water from this town have been examined at the State Laboratory of Hygiene. Of these two proved to be potable, and

one unfit for drinking. See Nos. 385, 507, and 606 of the table of analyses.

HAMPTON FALLS.—No public water supply.

But one private supply has been examined, and that was found to be badly polluted. For result see No. 507.

HANCOCK.—No public supply. Water is obtained from springs and wells. Water for the village is brought from wells a few feet deep, dug on a hill, thus obtaining an almost unlimited supply. The whole village supply is taken by individuals from this source.

The three supplies examined were all of excellent quality. For results see Nos. 414, 589, and 617.

HANOVER.—The Hanover water-works, installed in 1893, is an impounded water in a large artificial pond. The bed of the pond was a fertile valley, which was not cleared of vegetation before impounding the water. The dam went into blue clay, and exposed much. The watershed is fertile, and there are several houses on it. Water is unlimited in quantity, and has a head of over one hundred and fifty feet. This water has gone through a great variety of conditions, as was to be expected. The second winter it developed the characteristics of an effervescing chalybeate sulphur water, sulphuretted hydrogen being the main feature. In 1899-1900, *uroglera* appeared, and the water was intolerable for a time. It has appeared in a lesser degree since. Frogs innumerable bred in the reservoir, but have disappeared since it was stocked with bass. The water has always been colored, rich in dissolved vegetable matter, with some little taste and odor, though usually not offensive. It will probably be a long time before the supply approaches the conditions of a natural pond water. The distributing mains are of cast iron; service pipes, galvanized iron. The Hanover Aqueduct Association, a private corporation, furnishes a water that is used largely, though not exclusively, for drinking purposes. It is a normal spring water, the wells being four or five in number and dug to a depth of twenty feet, and yielding 4,000 gallons per day. The water is conveyed through lead pipe, running constantly, without much lead, and is stored in small reservoirs in the houses. The lead pipe and the possibility of unclean reservoirs are the only objections to the supply. There are very few individual wells in this locality.

Chemical Examination of Water from Supply of the Hanover Water-Wor Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Remarks.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.			
	1893.													
...	Oct. 29	Mark.	Much	.....	Faint yel. brown	8.10	4.00	.0170	.0240	.0000	.0000	*	2.90	Reservoir filling
...	Nov. 27	Mark.	.....	.....	Faint yel. brown	7.20	2.68	.0080	.0170	.0000	.0000	*	2.70	Reservoir half full
...	Dec. 29	Faint	.....	.....	Faint yel. brown	6.08	3.16	.0038	.0178	.0000	.0000	.10	2.70	Heavy thaw
	1894.													
...	Jan. 26	None	None	.....	0.7	8.50	.....	.0088	.0224	.0000	.0000	.26	....	Heavy thaw
...	Feb. 8	None	None	Foul	0.7	8.50	4.60	.0010	.0132	.0000	.0000	.20	4.10	Offensive
...	Mar. 8	None	None	Slight	0.3	10 00	5.70	.....	.....	.....	.....	.40	1.92	Heavy thaw
...	Apr. 10	Slight	.....	.....	0.3	4.88	1.80	.....	.....	.0400	.0000	.16	....	.....
...	Dec. 27	.....	.....	.....	0.7	.....	.....	.0003	.0250	.0200	.0000	.05	2.99	Sample fro' pipes
	1896.													
...	Mar. 20	.....	.....	.....	0.5	5.28	2.64	.0066	.0180	.0000	.0000	.10	1.43	.....
	1902.													
798	Sept. 11	Very slight	Slight veg.	V. decid. & earthy	0.55	8.80	3.30	.0020	.0230	.0000	.0000	.09	2.20	.....

* Trace.

We are indebted to Prof. Edwin J. Bartlett of Dartmouth College for all but the last of the analyses. They were made by him while the supply was being introduced and the year following, when the water was in a bad condition. The water is now of the same general character as in 1896. The color and odor are very pronounced, and the albuminoid ammonia is very high.

HARRISVILLE.—No public water supply.

Four samples from three supplies have been examined during the past year, and all found unfit for use. One was badly contaminated by lead and the others by sewage effluents. For results see Nos. 144, 221, 247, and 443.

HART'S LOCATION.—No public supply.

HAVERHILL.—No public supply. The Haverhill Aqueduct Company, a stock company, built a system of water-works for the town more than fifty years ago, the source of the supply being a spring. Water flows by gravity through lead main and service pipes. Fifty-two families, nine tenths of all the inhabitants, are takers of this water.

Chemical Examination of Water from Faucet of Haverhill Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evap'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
771	1902. Sept. 3	None	None	None	0.0	6.10	3.90	.0000	.0060	.0300	.0000	.06	3.60	.....	g

One well has been examined, and found to be unfit for use. See No. 74 in table of analyses.

Hebron.—Water supply of the town is obtained from individual wells and springs.

Henniker.—No public supply. Water is from the private supplies of the Henniker Spring Water Company, installed in 1884, and the Dow System, installed in 1874. The sources are springs and wells. The wells are dug. The quantity of water, both systems, is estimated to be 4,000 gallons per day. Water flows by gravity to reservoirs 34 x 27 feet, 17 feet deep; 34 feet diameter, 12 feet deep; 8 feet diameter, 7 feet deep. There is estimated to be about four miles of distributing mains. All pipe used is of galvanized iron. There are no private wells in the locality.

Chemical Examination of Water from a Faucet of the Henniker Spring Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
745	1902. Aug. 26	None	None	None	0.0	5.90	4.50	.0000	.0000	.0100	.0000	.07	2.60	.....	g

Sample from one spring has been examined, brought through lead pipe. Water contained small amount of lead. See No. 581.

Hill.—No public supply. There are two private supplies in town, One owned by George A. Sumner, constructed in 1890, is taken from a

stream about a mile long at the dam. The pond thus formed is about one half an acre in area and ten feet deep. The sewage from a shop, employing fifteen hands, empties into this stream. Fifteen families are supplied with water from this source, through one mile of galvanized iron distributing mains and galvanized iron service pipes. There are eight wells and three aqueducts within the radius of this supply. In 1893 a supply from a spring was introduced by Mr. F. R. Woodward. This spring flows about fifty gallons per minute; soil sand and clay. The mains, of cement and iron, are one and a half miles long, while the service pipes are of galvanized iron. The average daily consumption by the thirty families taking this water is 4,000 gallons. There are only two wells within the radius of this supply.

Chemical Examination of Water from a Faucet in Hill, Supplied by F. R. Woodward's Water Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
761	1902. Sept. 2	None	None	None	0.0	6.00	2.50	.0000	.0028	.0700	.0000	.22	1.80	.....	g

Chemical Examination of Water from a Faucet in Hill, Supplied by Geo. A. Sumner's Water Supply.

Number.	Date of collection.	Appearance.				Residue on Eva po'n		Am monia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
786	1902. Sept. 9	V. slight	V. slight	Slight veg.	0.25	8.70	1.50	.0000	.0036	.0000	.0000	.10	1.40	.....	g

Hillsborough Bridge.—The Hillsborough Bridge Village Fire Precinct owns a water supply, instituted in the autumn of 1886. The source is a pond of about 500 square acres; average depth about fifteen feet; bottom, sand and ledge, with natural deposit. The water flows by gravity to intermediate reservoir of 500,000 gallons' capacity. Surface area of

reservoir, 100,000 square feet. The distributing mains, four miles in length, are of cast iron, and cement-lined sheet iron, chiefly; service pipes are of galvanized iron. About 95 per cent of the population are served from this supply. There are very few individual wells in the locality.

Chemical Examination of Water from Faucet of the Hillsborough Bridge Village Fire Precinct.

Number.	Date of collection.	Appearance.				Residue on Eva po'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
746	1902. Aug. 20	None	None	None	0.2	3.70	1.30	.0000	.0060	.0120	.0000	.12	1.20	.....	g

One sample from a private supply from a brook has been examined. Good water, but traces of lead. See No. 495.

HINSDALE.—No public supply. Every family has a private well.

Fifteen samples have been examined, twelve of which are private supplies. Three examinations were made of proposed supplies, and aside from a high organic content the waters were of good quality. Seven private supplies proved to be pure, and five were found to be badly contaminated. For results see Nos. 42, 43, 44, 45, 84, 85, 86, 87, 101, 102, 103, 104, 223, 460, and 503.

HOLDERNESS.—Nearly all the water used in town is from wells and springs.

Sample of water from one well has been examined, and found to be slightly contaminated, but not sufficiently to condemn it. See No. 137 in table of analyses.

HOLLIS.—No public or private water supplies.

Two samples of water from this town have been analyzed at the State Laboratory of Hygiene, and both were pronounced good. See Nos. 116 and 488 in the table of analyses appended.

HOOKSETT.—No public supply. There are two private supplies. One, owned by Mrs. M. C. Towle, is from a brook which has been dammed. The watershed extends for about half a mile on each bank. The other supply, owned by Henry C. Carbee, is from a pond supplied by springs.

The water is pumped to a reservoir having a capacity of about 40,000 gallons. There are about two miles and a half of 2½-inch iron distributing mains; service pipes of 1½-inch iron. Seventy-five families are supplied from these sources, 10 per cent of the population. There are many private wells in the locality.

*Chemical Examination of Water from Various Sources in Hooksett.**

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
865	1902. Oct. 16	V. slight	Floc.	Veg.	0.9	4.60	1.40	.0000	.0114	.0000	.0000	.17	1.30	.....	g
866	Oct. 16	None	None	Slight veg.	0.0	3.40	1.20	.0000	.0042	.0000	.0000	.17	.90	.....	g

*Sample No. 865 is from supply of Mrs. M. C. Towle; No. 866, from that of Mr. Henry C. Carbee.

One well supply was examined and found to be very badly polluted. For result see No. 616 in table of analyses.

Hopkinton.—No public supply. There is a private supply, introduced by the Hopkinton Village Aqueduct Association, from springs and wells. The wells are dug from eight to ten feet deep. It is a gravity system. The reservoir is 10 x 10 x 8 feet. The distributing mains are from one to two miles in length, and are of iron; service pipes mostly of lead. Fifty or more families, seven eighths of the population of Hopkinton village, are consumers. There are but few private wells in the locality.

Chemical Examination of Water from Supply of Hopkinton Village Aqueduct Association.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
876	1902. Oct. 16	None	None	None	0.0	8.90	4.20	.0000	0000	.0300	.0000	.15	1.60	.....	g

One well supply was examined and found to be of excellent quality. For result see No. 181 in table of analyses.

HUDSON.—No public supply. The Hudson water-works, owned by a private company, were built in 1892. The source of the supply is a well twenty feet deep and twenty-two feet wide, dug through loam and gravel. The water is pumped to a standpipe twelve feet in diameter and sixty feet high. There are about four miles of distributing mains, of iron, as are also the service pipes. Seventy-five families are thus supplied, one tenth of the entire population of the town. There are six or seven wells within the radius of this supply.

*Chemical Examination of Water from Well Supplying Town of Hudson.**

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
69	1901. July 16	None	Slight floc.	None	0.0	6.00	3.70	.0014	.0026	.1000	.0000	.40	.....	.....	g
135	Aug. 26	None	Slight floc.	Faint veg.	0.0	20.60	9.60	.0068	.0024	1.2000	.0044	.44	3.50	.....	b
164	Sept. 16	Marked	Much min.	Peculiar	0.0	15.00	7.50	.0024	.0036	1.2000	.0014	.39	4.10	.....	b
183	Sept. 30	Marked	Much min.	Faint oily	0.0	16.30	9.40	.0062	.0044	.7700	.0077	.39	5.90	.....	b
272	Nov. 7	Marked	Much floc.	Foul	0.0	19.30	12.00	.0320	.0088	.3333	.0380	1.19	.....	.....	b

Samples Nos. 135, 164, 183, and 272 are from well near Smith's schoolhouse. This supply is a driven well made within a year for the purpose of supplying Smith's school. So far as can be determined it is located away from all contaminating substances, and no explanation can be given for the peculiar results of the analyses.

In addition to the analyses recorded above, nine private supplies were examined, of which five were good, three were bad, and one doubtful. For results see Nos. 129, 362, 395, 396, 410, 435, 436, 461, and 233 of the appended table of analyses.

JACKSON.—No public water supply. Most of the farmers and boarding-houses are supplied from individual springs on their premises. A part of the village use well water, which is considered questionable.

One sample examined was found to be of doubtful quality. For results see No. 429.

JEFFERSON.—No public supply. The chairman of the board of health writes: "Jefferson has no public water supply. The Waumbek Hotel Company have a fine supply system of their own from natural springs and

spring brooks. The different families have their own private water supplies, chiefly from springs, through iron pipes, directly to their houses and stables. Galvanized iron and cast-iron pipes are also used, and some few fir balsam logs. In a few wells on the flat lands, chain pumps, well-sweeps, patent suction pumps, and the old-fashioned pole and pail are used. Mountain springs are the chief sources of our supply, supposed to be pure."

*Chemical Examination of Water Supply of the Waumbek Hotel Company.**

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
184	1901. Sept. 30	None	None	None	0.0	3.80	1.80	.0016	.0042	.0480	.0000	.03	.....	.....	g

* Sample from spring east of main hotel.

JAFFREY.—The town instituted a system of water-works in 1902, the source being a pond in Rindge having an area of forty acres, an average depth of twenty feet, with hardpan bottom. The water flows by gravity through nine miles of 12-inch, cast-iron distributing mains; service pipes, 6-inch cast iron. It is estimated that one hundred and fifty families will become takers this year, 1902. Prior to the installation of this supply, Mr. Albert Annett, a member of the committee appointed by the town of Jaffrey to investigate the subject of a town system of water-works, was in communication with the State Laboratory of Hygiene, and collected several samples of water from the proposed supply, which were examined and reported upon by the laboratory. Following is the correspondence with Mr. Annett, together with the results of the analyses:

EAST JAFFREY, N. H., September 23, 1901.

State Board of Health, Concord, N. H.:

GENTLEMEN,—I have today sent you by express, prepaid, a bottle containing water taken from Bullet pond, in the town of Rindge. This pond is a proposed source of water supply for the town of Jaffrey, and we would like a chemical and bacteriological examination of this water, and would like your report in such form that it can be printed in connection with our committee report to the town.

Yours very truly,

ALBERT ANNETT,
Committee.

LABORATORY OF HYGIENE,

CONCORD, N. H., October 10, 1901.

Albert Annett, East Jaffrey, N. H.:

DEAR SIR,—Please find inclosed the results of the chemical examination of Bullet pond water.*

I trust that the delay in reporting results will not inconvenience you, but we have been making a thorough bacteriological examination, which seems to be very necessary.

I am sending you, by express, this morning a small bottle which I desire filled and returned so we may make a second bacteriological examination with fresh water.

Can you tell me if Bullet pond is used as a picnic ground or resort by parties and if it is also used for bathing purposes?

I will send you a complete report as soon as possible after the receipt of the second sample.

Very respectfully,

H. E. BARNARD.

Chemist.

LABORATORY OF HYGIENE,

CONCORD, N. H., November 1, 1901.

Albert Annett, East Jaffrey, N. H.:

DEAR SIR,—A bacteriological examination of the second sample of Bullet pond water does not confirm the results we obtained on the first sample, and I am sure the peculiar results we observed at the first examination were in no way due to the condition of the pond water, but rather to some unknown contamination, possibly introduced in sampling, or perhaps at the laboratory.

The chemical examination gives results agreeing with those sent you, and the bacteriological examination does not reveal any polluting material except many cyclops which, since they are large enough to be readily seen in a glass of the water when held to the light, may present an apparent objection to the use of the water for drinking. They will, however, disappear from the water in its passage through the pipes and their presence cannot be considered harmful.

I consider the water quite suitable for drinking and am sure it will furnish you with a supply much clearer and more free from organic matter than most of our pond waters.

If you desire any further examinations we shall be very pleased to make them, or to aid you in any way in securing a suitable supply for your town.

Very respectfully,

H. E. BARNARD,

Chemist.

EAST JAFFREY, N. H., December 23, 1901.

H. E. Barnard, State Chemist, Concord, N. H.:

DEAR SIR,—Referring again to your analysis of Bullet pond water, made for me in October, you speak of many cyclops that appeared in the sample

*For results of examination see No. 186 in the table of analyses.

submitted to you. I have no knowledge of this matter, but it has occurred to me that this pollution might be due to the manner in which the water was obtained. To get this sample I took an old fishing boat that was sunk on the shore, and I noticed at the time that the boat was covered with a slime, but as there was nothing better at hand I used it. If the cyclops were anything that came from the slime on the boat there was probably a much larger number of them in the sample sent you than would be found in the pond at large. The pond is now frozen over, and if an examination made now would be a fair test of the qualities of the water I would like to have you send me two of the flasks and I will send you samples for another analysis.

Much interest is being taken in the subject of water-works, owing to an epidemic of typhoid fever that we had during the summer, and I am one of a committee appointed to investigate the subject of a water supply and prepare a printed report to be distributed to the voters of the town.

Bullet pond appears to be our only available source, and from its situation it seems less liable to pollution than any other body of water in this section. The committee would like a complete chemical and bacteriological examination, and would like it in form to be printed with the committee report, and in such terms as to be understood by the ordinary voter.

Thanking you for your offer of further aid contained in your previous letter, and awaiting your reply, I remain,

Very truly yours,

ALBERT ANNETT,
For the Committee.

LABORATORY OF HYGIENE,

CONCORD, N. H., January 16, 1902.

Albert Annett, East Jaffrey, N. H.:

DEAR SIR,—In reply to your communication of September 23, 1901, requesting a chemical and bacteriological examination of Bullet pond water, which it is proposed to use as a source of water supply for the town of Jaffrey, the State Board of Health has investigated the pond and its surroundings, and has made several analyses of the water, the results of which are appended in full.

It appears that Bullet pond is an exceptionally clear and transparent body of water, very nearly free from water grasses, lily pads, and vegetable growths of any sort. It is situated between hills, and the shores are, for the most part, steep, and the water deep, varying from ten to sixty feet. It is remote from any village and is but little frequented for bathing, or for camping and picnics. There are three houses about the pond, but none are within six hundred feet of the shore. From its situation the pond does not seem liable to receive any polluting material.

The results of the various analyses, which have extended over several months, have been uniform, and show the water to be of good quality, very soft, free from turbidity and sediment, with a slight vegetable odor and color, due to dissolved organic matter. This may be much improved by cleaning the shores, removing decayed vegetation, and preventing excessive surface wash into the pond. The chlorine content is normal for your town; the solids are very low; ammonia in its oxidized conditions, as nitrites and

nitrates, is absent; and that present as free and albuminoid ammonia is wholly due to the vegetable matter always found dissolved in pond water.

The bacterial examination shows the water to be practically free from bacteria, but the biological examination shows cyclops of the order *Copepoda crustacea*, to be present in considerable numbers. The cyclops are aptly called "water scavengers," and are found very generally in our best pond supplies. Their presence is not considered detrimental, and as it is but rarely that they pass through the service pipes to the consumers, they will undoubtedly never give trouble.

Taking into consideration the location of the pond, and the uniformly good condition of the water, it would seem to be a wholly satisfactory source of water supply.

If you wish further investigations, we shall be glad to assist you by making such analyses as you may require and will give you such further advice as may seem desirable.

Very respectfully,

H. E. BARNARD,
Chemist.

Chemical Examination of Water from Bullet Pond, Rindge.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
186	Oct. 1	None	Slight veg.	Decided veg.	0.12	2.80	1.30	.0016	.0166	.0000	.0000	.16	.....	.....	...
232	Oct. 20	None	None	Veg.	0.12	....	.....	.0016	.0180	.0000	.0000	.09	.....	.....	*
	1902.														
349	Jan. 5	None	None	Veg.	0.2	2.30	1.10	.0032	.0172	.0000	.0000	.08	.40	.....	†
348	Jan. 5	None	None	Veg.	0.2	2.50	1.10	.0032	.0162	.0000	.0000	.09	.40	.....	...

*A bacteriological examination does not show the presence of polluting material. Crustacea Copepoda present.

†Crustacea Copepoda, 80 per litre; bacteria, none; other forms of animal or vegetable life, none.

In addition to the examination of Bullet pond water, fourteen other supplies were examined, of which eight were badly polluted and six suitable for drinking. For results see Nos. 187, 188, 206, 207, 208, 235, 238, 239, 312, 322, 390, 450, 539, 558, 575, 576, 620.

KEENE.—In 1870 the city of Keene installed a public water supply from two ponds, one fifty acres and the other one hundred and ten acres in area; Sylvan lake having an average depth of twenty feet, and Echo lake, twelve feet. The water flows by gravity. The distributing mains, iron and cement, are about thirty-six miles in length; service pipes are of

iron. The average daily consumption is 1,358,000 gallons, nearly all of the city proper, 8,200 persons, being consumers. There are no wells.

Chemical Examination of Water from Keene.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
27	1901. June 24	V. slight	Slight floc.	Decided veg.	0.2	2.80	1.00	.0000	.0169	.0000	.0000	.18	.....	.....	*
455	1902. Mar. 27	Slight	Slight	Veg.	0.23	1.60	.70	.0010	.0122	.0150	.0000	.07	.70	.....	†
456	Mar. 27	Slight	Slight	Veg.	0.23	2.00	1.00	.0020	.0076	0000	.0000	.07	.70	.....	‡
457	Mar. 27	V. slight	Slight	Veg.	0.32	3.10	.80	.0009	.0052	.0000	0000	.07	.60	.....	§
458	Mar. 27	Marked	Slight	Veg.	0.12	2.10	.80	.0010	.0078	.0000	.0000	.11	.60	.....	¶

* Sample from Goose Pond. † Sample from intercepting reservoir.
‡ Sample from stream proposed as an additional supply.
§ Sample from small stream flowing through an alder swamp.
¶ Small stream, part of proposed supply.

In addition to the examinations of the public supply, three well samples were analyzed and all found badly polluted. One of these supplies contained an excessive amount of lead. See Nos. 417, 521, 523, 524, 605, 634, 740 in table of analyses.

KENSINGTON.—There is no water supply in town, other than individual wells and springs.

KINGSTON.—There is no public water supply. The people draw their individual supplies from private wells, dug from ten to twenty-five feet through light, dry, sandy soil. Samples have been analyzed in a few cases when contamination was suspected.

LACONIA.—No public supply. The Laconia Water Company is a corporation established in 1885. The supply is pumped from Lake Winnipesaukee to a reservoir of 2,750,000 gallons' capacity. There are eighteen miles of cement lined and ten miles of cast-iron mains; the service pipes are wrought iron, cement lined. The average daily consumption is 350,000 gallons.

Chemical Examination of Water Supply of Laconia and Lakeport.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
532	1902. May 19	None	V. slight	Slight veg.	0.1	2.80	.90	.0000	.0014	.0000	.0000	.13	.60	.....	*g
822	Sept. 22	None	None	V. slight	0.1	4.00	1.10	.0000	.0062	.0000	.0000	.11	.60	.....	†g

*** Sample from Little Bay.**

† Sample from a faucet at pumping station of the Laconia Water Company.

One private supply has been examined and pronounced good. See No. 227 in table of analyses.

An analysis has also been made of a sample from Lake Winnisquam, which was found to be of excellent quality. See No. 531 in table of analyses.

LANCASTER.—The Lancaster Water Company works were installed in 1891, and transferred to the precinct in 1894. The source of the supply is a mountain stream, wooded land, no inhabitants. The water flows by gravity, through six miles of cast-iron mains; service pipes are also of cast iron. All the families in the precinct are supplied from this source; there are no wells within the circuit.

Chemical Examination of Water from Faucet of Precinct Water-Works.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
813	1902. Sept. 19	None	None	V. slight	0.1	3.40	1.50	.0000	.0012	.0200	.0000	.05	1.50	.....	g

LANDAFF.—No public supply. The town is supplied with water from springs and wells. There are several public watering places on different roads.

LANGDON.—No public or private system of water-works. The people obtain water from private wells and springs.

LEBANON.—The water supply is owned by the Fire Precinct, and was installed in 1897. At first the water was taken from a stream flowing from Mascoma lake, but at present from wells, 63 x 30 x 15 feet, supplied by nine hundred feet loose-jointed pipe, taking water from subsoil mainly, the remainder being filtered through twenty-five feet of natural soil into the said pipe. The water is pumped to a reservoir of 1,000,000 gallons' capacity, being fourteen feet at the deepest point. There are ten miles of cast-iron distributing mains; service pipes, wrought iron. The average daily consumption is from 200,000 to 350,000 gallons, by seven hundred families.

The chairman of the board of health writes: "Mascoma lake receives water from Mascoma river, on which are sawmills and factories. At the head of the lake a small stream enters which receives sewage along its course. The lake also receives sewage from the Shaker buildings and from the village of Enfield."

Chemical Examination of Water from Reservoir Well.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
33	1901. June 27	None	Slight floc.	Slight veg.	0.3	4.60	2.80	.0000	.0115	.0000	.0000	.22	.....	.....	g
34	June 27	None	Min. matter	V. slight	0 0	7.60	5.30	.0000	.0000	.0100	.0000	.31	.....	.....	g
53	July 6	Marked	Much min.	None	0.0	6.70	4.10	.0073	.0098	.0000	.0000	.33	.....	.....	g
54	July 6	None	Min.	None	0.0	6.00	3.40	.0028	.0100	.0900	*	3 51	.....	.....	g
614	1902. June 25	Slight	V. slight	Aromat. veg.	0.2	7.00	2.60	.0006	.0082	.0330	.0000	.12	1.80	.....	g

* Trace.

Six samples from private sources have been examined, of which three were pronounced good, two of doubtful quality, and one bad. See Nos. 48, 182, 269, 268, 270, 271 in table of analyses.

LEE.—There is no water supply other than wells and springs.

LEMPSTER.—No public supply, water being obtained from individual wells.

LISBON.—No public supply. The Lisbon water-works, owned by a private company and installed in 1887, is supplied from a pond fed by springs. The area of the pond is one hundred acres; the bottom is gravelly.

The water flows by gravity, and the reservoir has a capacity of one million gallons. All the pipes used, of which there are seven miles of distributing mains, are of wrought iron and cement. The average daily consumption is 250,000 gallons. About 90 per cent of the population are supplied from this source.

Chemical Examination of Water from the Reservoir of the Lisbon Water-Works Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
796	1902. Sept. 9	Slight	Consid. floc.	V. slight	0.0	6.90	2.60	.0000	.0066	.0000	.0000	.08	2 30	.....	g

Samples from one spring and one well have been examined: Spring water good. The well was badly contaminated with dynamite in digging, and was reported unfit for use. Thorough cleaning the well removed the offensive pollution and subsequent analysis showed the water to be good. See Nos. 10, 158, 360.

Lincoln.—No public supply. In 1892 J. H. Henry & Sons introduced a system of water-works from a stream. The water flows by gravity. The mains, of iron, are about five eighths of a mile in length; service pipes are of iron. About eighty-five families, two thirds of the town, take this water.

Chemical Examination of Water from Faucet of Supply of J. H. Henry & Sons.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
762	1902. Sept. 1	None	V. slight	V. slight veg.	0.1	4.80	1.90	.0000	.0044	.0150	.0000	.05	.30	.....	g

LITTLETON.*—No public supply. The Littleton Water & Light Company operates a system of water-works instituted in 1880, from which about three hundred families are supplied. The water is taken from Ammonoosuc river, which receives sewage from towns above, and is pumped to a reservoir of half a million gallons' capacity. Gravity 4-inch pipe, 105 feet head, is 7,500 feet in length. There are nearly nine miles of 4-inch, 6-inch, and 8-inch cast-iron distributing mains; service pipes are iron and lead. The average daily consumption is 200,000 gallons. About 90 per cent of the population are supplied from this source.

Chemical Examination of Water Supplied by the Littleton Water and Light Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
7	May 26	Slight	Much floc.	Slight veg.	0.4	4.10	1.90	.0018	.0155	.0000	.0000	.06	.....	.....	*
8	May 26	V. slight	V. much veg.	Slight veg.	0.3	3.80	1.60	.0016	.0067	.0000	.0000	.08	.....	.....	†
9	May 26	V. slight	V. much veg.	V. slight veg.	0.25	4.70	1.60	.0012	0073	.0000	.0000	.07	.....	.....	‡
88	July 26	None	Much floc. veg.	Faint veg.	0.2	4.00	2.20	.0032	.0130	.0050	.0000	.12	.....	.....	*
89	July 26	None	Much floc. veg	Faint veg.	0.2	3 90	2.60	.0032	.0114	.0050	.0000	.12	2.40	.....	‡
151	Sept. 6	None	Much floc.	Decided veg.	0.12	2.10	1.00	.0008	.0082	.0090	.0000	.10	.....	.....	‡
185	Sept. 30	None	Floc. veg.	Faint veg.	0.2	3.70	1.90	.0026	.0096	.0000	.0000	.10	....	.....	§
	1902.														
444	Mar. 13	Slight	Floc. veg.	Veg.	0.3	9.10	2.20	.0018	.0076	.0100	.0000	.04	1.10	.....	‡
573	June 5	V. slight	Slight	Decided veg.	0.25	7.30	2.00	.0000	.0052	.0180	0000	.09	1.90	.....	‡
686	Aug. 4	Slight	Slight floc.	V. decid. veg.	0.5	4.90	1.40	.0000	.0098	.0000	.0000	.07	1.40	.....	*
687	Aug. 4	Marked	Floc.	Veg.	0.5	4.00	1.50	·0000	.0066	.0000	.0000	.07	1.20	.....	‡

* Sample taken from river near intake. † Sample taken from tap at schoolhouse.
‡ Sample taken from tap at house of Dr. G. F. Abbott.
§ Sample taken from dead end of pipe at Apthorpe.

LONDONDERRY.—No public supply.

LOUDON.—No public supply. All the water is obtained from wells and springs.

Six private supplies have been examined, of which five were found to be polluted and unfit for drinking; the other was classed as good. See Nos. 15, 29, 213, 224, 328, and 297 in the table of analyses.

* Also see special report on the "Pollution of Ammonoosuc River" in Vol. 16, Report of State Board of Health.

LYMAN.—No public supply. Water is obtained from wells and from springs, through lead pipe or logs.

LYME.—In 1838 the Lyme Aqueduct Company inaugurated a system of water-works, the source being springs. The water flows by gravity through lead, tarred-iron, and galvanized-iron mains, with lead service pipes. The average daily consumption is 4,300 gallons. Thirty-three families are so supplied.

Chemical Examination of Water from Supply of Lyme Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
772	1902. Sept. 3	None	V. slight	None	0.0	8.40	4.70	.0000	.0018	.0250	.0000	.08	4.70	.....	g

LYNDEBOROUGH.—No public water service; simply individual wells and springs.

One well has been examined, and was found to be polluted and unfit for use. See No. 528 in the table of analyses.

MADBURY.—No public supply; individual wells.

MADISON.—No public supply. The Silver Lake Reservoir Company, in 1886, introduced a supply from a natural spring. The water is pumped to a reservoir of 512 cubic feet capacity. Galvanized iron is used for main and service pipes. The average daily consumption is about 4,000 gallons, by ten families.

MANCHESTER.—A water supply was instituted by the city in 1873, was added to in 1886, and supplemented by a high service in 1894. The source is Lake Massabesic, having an area of 2,500 acres, an average depth of twenty feet, and a bottom partly rocky and partly muddy. It has approximately forty miles of watershed, wooded and cleared about equally. Some sawdust enters the lake. The water is pumped to a reservoir of 15,000,000 gallons' capacity, and an average depth of twenty feet. There are one hundred miles of distributing mains, iron; service pipes are iron, lead lined. The average daily consumption is 3,000,000 gallons. Twelve thousand two hundred families, nine tenths of the

population, are consumers of this water. There are not many individual wells within the radius of this supply.

Chemical Examination of Water from Lake Massabesic.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
369	1902. Jan. 21	None	None	Decided veg.	0.8	5.70	1.20	.0054	.0204	.0000	.0000	.12	.70	.....	*
370	Jan. 21	None	None	Decided veg.	0.7	5.50	.70	.0044	.0228	.0000	.0000	.16	.70	.....	†
371	Jan. 21	None	None	Decided veg.	0.7	5.70	1.00	.0020	.0188	.0000	.0000	.21	.70	.....	‡
372	Jan. 21	None	None	Decided veg.	1.0	9.10	1.60	.0012	.0156	.0000	.0000	.17	.70	.....	§
727	Aug. 22	None	Floc. veg.	Veg.	0.35	7.40	1.30	.0000	.0106	.0000	.0000	.17	1.20	.....	¶

* Sample taken at high service intake.
† Sample taken at Deer Neck Bridge, Auburn.
‡ Sample taken halfway between Severance Beach and Battery Point.
§ Sample taken at mouth of Sucker Brook.
¶ Sample taken at tap in Board of Health building from low-service reservoir.

Chemical Examination of Water from Hanover Spring, Hanover Common.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
128	1901. Aug. 21	None	None	None	0.0	25.30	18.30	.0012	.0044	1.2000	.0000	3.72	8.20	.....	..
125	Aug. 19	None	None	None	0.0	25.60	20.30	.0020	.0022	1.2000	.0000	4.05	7.45	.....	*
728	1902. Aug. 22	None	None	None	0.0	22.60	13 40	.0000	.0000	.6000	.0007	2.90	7.20	.....	..
726	Aug. 22	None	None	None	0.0	28.00	17.70	.0006	.0038	.8000	.0000	3.45	6.80	.....	*

* Samples taken from tap at City Hall.

Hanover spring, situated in Hanover common, supplies the public fountains along Elm street. The spring is never-failing and originally furnished a very pure water. At present it is surrounded by a densely populated district, and each year is becoming more polluted. It is a peculiar fact that the last two examinations of water from the spring, made at an interval of one year, have shown a marked difference in composition, and that the chlorine content of water at the spring is lower than at the tap

in the city hall. Nitrites have appeared in the water at the spring this year, but not at the city hall tap. These peculiar discrepancies are as yet unexplained.

Chemical Examination of Spring Supplies.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
79	July 24	None	None	None	0.0	14.90	10.00	.0012	.0000	.6000	.0001	2.07	6.00	.....	*
81	July 24	None	None	None	0.0	5.70	3.80	.0014	.0034	.0800	.0000	.49	.....	.....	†
127	Aug. 21	None	Slight floc. veg.	Slight veg.	0.1	3.50	2.30	.0006	.0016	.0140	.0000	.29	.....	.....	‡

* Sample taken from McGregor Spring.
† Sample taken from spring at Derryfield Park, from faucet of iron pipe.
‡ Sample taken from Stark Spring.

Chemical Examination of Water from Various Supplies of State Industrial School, Manchester.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1902.														
498	May 5	None	None	None	0.0	9.70	5.60	.0026	.0034	.0800	.0000	.40	2.00	.....	*g
499	May 5	Slight	None	Slight veg.	0.0	7.60	4.50	.0000	.0026	.2500	.0000	.70	1.95	.....	†g
500	May 5	Marked	None	Marked stable	0.3	7.80	2.10	.0036	.0148	.0700	.0000	.40	1.60	.....	‡d

* Sample taken from bricked up spring west of pond.
† Sample taken from tank in top of main building fed by spring well near Union street.
‡ Sample taken from pond north of horse barn, while pond was turbid from heavy rains.

Thirty-seven supplies have been examined, of which fifteen were good, fourteen polluted, and eight of doubtful character. For results see Nos. 20, 79, 80, 81, 124, 125, 127, 128, 145, 146, 147, 148, 172, 173, 174, 281, 282, 283, 284, 323, 324, 325, 326, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 498, 499, 500, 510, 649, 670, 726, 727, 728, 729.

MARLBOROUGH.—No public supply. Water is taken from wells and springs through lead pipe.

Nine supplies have been examined and five of the number found to be of good quality. Two supplies were contaminated by sewage, and two otherwise pure supplies condemned because of the presence of quantities of lead in the water. For results see Nos. 154, 408, 420, 463, 534, 548, 561, 637, 697.

MARLOW.—No public supply. Families are supplied almost wholly from wells; a few have private springs.

The one supply examined was found to contain much lead and was doubtless the cause of a case of lead poisoning. For result see No. 354.

MASON.—There is no public water supply in the town. Wells and springs are the main source of supply, and are all owned by individual parties.

The one supply examined was badly polluted and unfit for use. For result see No. 412.

MEREDITH.—The Meredith Fire District owns and operates a water supply that was installed in 1894, the source being springs. The water flows by gravity from a reservoir on a hill. There is an ample supply, the reservoir never being more than two or three feet below high-water mark; an ample flow to supply the town. The area of the reservoir is about one hundred square rods. There are four and three fourths miles of iron distributing mains; service pipes are iron, with some lead lined. Ninety per cent of the families in the precinct take water from this supply. There are many private wells, also.

Chemical Examination of Water from a Faucet of the Supply of the Meredith Fire District.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
774	1902. Sept. 3	None	None	Decided veg.	0.2	6.10	1.60	.0020	.0074	.0000	.0000	.12	1.60	.....	g

Samples from two private wells have been examined, and both were found to be badly polluted. See Nos. 537 and 538 in table of analyses.

MERRIMACK.—No public or private system of water-works. The people of the town, with the exception of a few tenements, derive their water supply from wells. The tenements mentioned are supplied from a spring.

MIDDLETON.—No public supply. This is strictly a farming town, and each place has its individual well.

MILAN.—No public water supply. Water is obtained from individual wells. Samples from five of these were analyzed at the State Laboratory of Hygiene, and three of them condemned. For results see Nos. 509, 541, 545, 622, and 807.

MILFORD.—The public water-works of Milford were built in 1890 by John T. Langford, and purchased by the town in 1891. There are three collecting wells; two of them about thirty-five feet in diameter, and one twenty feet deep; one somewhat smaller is fed by driven pipes. Soil, gravel with clay bottom. The water is pumped to a standpipe of 250,000 gallons' capacity. There are about six miles of distributing mains, the pipe being iron, coated by the Smith process; service pipes are iron, cement lined. In 1901, the average daily consumption was 77,000 gallons. Five hundred and thirty-eight families, 50 per cent of the entire population, are supplied from this source. There are many private wells in the locality, but they are being gradually discarded.

Chemical Examination of Water from Faucet of Milford Water-Works.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
152	1901. Sept. 9	None	None	None	0.2	5.10	3.20	.0012	0074	.0120	.0000	.23	.....	.....	g
826	1902. Sept. 22	None	None	None	0.1	6.40	3.60	.0000	.0030	.0000	.0000	.13	3.40	.....	g
827	Sept. 22	V. slight	Slight	Slight	0.3	8.00	2.60	.0022	.0066	.0000	.0003	.18	2.60	.....	*g

*Sample taken from well of Milford Water-Works.

In addition to the examination of the water supply of Milford, seventeen other waters from that town were analyzed at the State Laboratory of Hygiene. Five were of good quality, one was doubtful, and eleven were unfit for drinking. Of the eleven bad waters, six were so classified because of the large amount of lead they contained. For detailed results

see Nos. 92, 130, 153, 233, 351, 468, 578, 603, 619, 662, 672, 671, 810, 815, 816, 828, and 829 in the appended table of analyses.

MILLSFIELD.—No public supply. All water is from private springs, of an average depth of about four feet; cobbly bottom.

MILTON.—No public water supply. The town is supplied by individual wells, springs, or cisterns.

MONROE.—No public water supply. The health officer writes: "Our water supply in Monroe is mostly from springs above buildings, with the exception of two hydraulics that pump water from a ravine below the village at Monroe Plain. There is no sewerage system at the village, the soil is sandy loam, and the springs must take the drainage of buildings that stand just above. I was called this summer by our pastor to look at the water, and boxes that carry the water to the hydraulics. I found that the boxes contained a dark green sediment, which smelled very rank. I would advise that this water be analyzed. Several families in the village are having wells bored here on the plain, and I think some of the waste water from sinks runs on the ground within three feet of wells; privy not over ten or fifteen feet from and above well, which must take the drainage from both through this sandy soil."

One supply only was analyzed, and that found to be of superior quality. For result see No. 508.

MONT VERNON.—No public water supply. There is one town pump. Each dwelling, almost without exception, has its private well.

The two samples examined were both of doubtful quality. For results see Nos. 66 and 156.

MOULTONBOROUGH.—No public water supply.

The one supply examined was unfit for use. For result see No. 222.

NASHUA.—No public supply. A private supply, the Pennichuck waterworks, installed by Nashua Aqueduct Company, in 1853, has for a source springs and wells. The wells, from sixteen to fifty-two feet in depth, are driven through alternate layers of marl, sand, fine gravel, and coarse gravel, and flow from twenty gallons to 275 gallons per minute. The reservoir, of 4,000,000 gallons' capacity, is thirteen feet in depth. There are about seventy-five miles of cast-iron distributing mains; wrought iron, galvanized, is used for service pipes. The average daily consumption is 3,500,000 gallons, by 4,000 families, about 95 per cent of the population. There are not over five or six wells.

Chemical Examination of Water from Tap of Pennichuck Water-Works Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
750	1902. Aug. 26	None	None	Slight veg.	0.0	6.00	1.50	.0000	.0000	.0000	.0000	.15	1.50	.....	g

The water from six other supplies was examined. Four supplies were of good quality, one was bad, and one doubtful. For results see Nos. 47, 56, 100, 378, 546, 650.

New Boston.—No public supply. The water supply of New Boston is from individual wells and springs.

Newbury.—No public supply. At Blodgett's Landing there are two small private supplies from springs. There are two small reservoirs, one supplying twelve or fifteen families; the other, five or six families.

Newcastle.—No public supply. Water is supplied by private wells and cisterns.

New Durham.—There is no public water supply in town. The individual family supply is from wells, principally dug wells, a few bored ones, and a few springs. The water is generally cold and tastes well, but has not been analyzed this year.

Newfields.—No public water supply. Water all taken from wells or cisterns.

One of the two supplies examined was badly polluted; the other was suitable for use. For results see Nos. 562 and 563.

New Hampton.—No public water supply in town. Most of the water is taken from shallow wells, through lead pipe. Several persons have suffered from lead poisoning. Several samples of the water have been analyzed at the State Laboratory of Hygiene, and lead found in most of them.

Eight supplies were examined and five found to be unsuitable for drinking because of the quantity of lead present in the water. Aside from the presence of lead the waters were pure and quite suitable for

drinking. For results of analyses see Nos. 196, 225, 226, 330, 346, 418, 440, 465.

NEWINGTON.—No public water supply.

NEW IPSWICH.—No public water supply. Water is taken about evenly from wells and springs.

Three samples of water from this town have been analyzed, one of which was suitable for drinking and two dangerous because of the large amount of dissolved lead in the water. For results see Nos. 295, 572, 643.

NEWPORT.—The town owns and operates a system of water-works supplied by a pond, or lake, of sixty-six acres; average depth about thirty feet; bottom largely sand and rock. The watershed is about four or five square miles, about two-thirds wooded; three families reside thereon. It is a gravity system of 12⅓ miles of distributing mains, cast iron; service pipes wrought iron and cement lined. About four hundred families, 50 per cent of the population, are consumers. There are also one or two individuals who sell spring water. There are many individual wells in the locality.

Chemical Examination of Water from Tap of Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
844	1902. Oct. 9	None	None	Veg.	0.1	6.90	1.20	.0000	.0048	.0000	.0004	.10	.90	.....	g

The water from six other supplies was examined. Of these three were good and three bad. For results see Nos. 466, 486, 519, 604, 655, 711.

NEW LONDON.—No public supply; water mostly from wells.

NEWTON.—No public water supply. Nearly every family has a well, some more than one. A few have no well, and depend upon neighbors for water.

One well has been examined and pronounced unfit for drinking purposes. See No. 214 in table of analyses.

NORTH HAMPTON.—No public supply. A charter is held by the North Shore Water Company, and the matter of supplying Little Boar's Head and Rye Beach with an ample supply of good water has been talked of for the past year, but as yet no well-defined plan has been reached.

NORTHFIELD.—No public supply. The Tilton & Northfield Aqueduct Company, a private corporation, instituted, some fourteen or fifteen years ago, a water supply, the source being a pond fed by springs. The land is cleared for some distance from the water, and there are no houses within one half mile. The water runs by force of gravitation in pipes to a reservoir. The distributing mains are of iron; service pipes, galvanized iron. There are not many individual wells in the vicinity.

Chemical Examination of Water from a Faucet of the Tilton & Northfield Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
11	May 28	V. slight	Slight	Distinct veg.	0.2	3.40	1.30	.0019	.0150	.0000	.0000	.09	.....	.....	g
345	Dec. 31	None	None	None	0.2	2.90	1.20	.0044	.0136	.0050	.0000	.09	.90	.....	g

NORTHWOOD.—No water supply other than individual wells and springs. Of the three supplies examined at the State Laboratory of Hygiene, two were found to be good, and one badly polluted. For results see Nos. 309, 321, and 388.

NOTTINGHAM.—No public supply. Water is obtained from wells and springs. Wells are dug from fifteen to thirty feet deep.

Two wells have been examined, and both pronounced unfit for use. See Nos. 138, 286, in table of analyses.

ORANGE.—No public supply. All the water is obtained from private wells or springs.

ORFORD.—No public supply. There are private supplies from springs, which furnish water to some thirty families. These springs are dug from six to eight feet deep, through sandy loam, subsoil rock. The water flows by gravity through iron and lead mains, with lead for service pipes. There

are no individual wells in the vicinity. There are several other private springs.

Chemical Examination of Water from the Wilcox Springs.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
766	1902. Sept. 2	V. slight	Slight floc.	None	0.0	5.60	4.30	.0000	.0000	.0000	.0000	.05	3.20	.....	g

Sample from a private tap was examined, and found to be excellent; also sample from tap at schoolhouse was found to be excellent water, with the exception of traces of lead. See Nos. 30 and 320 in table of analyses.

Ossipee.—There is no public water supply.

Of the four supplies examined, three were of good quality, one, spring water, was polluted and unfit for use. For results see Nos. 16, 386, 413, and 478.

Pelham.—No public water supply. All the houses in town but two are supplied by wells, which are believed to be in good condition. The two exceptions are supplied from springs, through lead pipes to cisterns in the houses. The water is charged with carbonic acid, which prevents poisoning.

Pembroke.—No public supply. There are two private supplies. The Suncook water-works, built in 1896, is supplied from a pond having an area of twenty-five acres, fifteen feet deep on an average, and a very muddy bottom. No inhabitants within two or three miles. The water flows by gravity. There are nine miles of distributing mains, cast iron; service pipes of galvanized iron. About 50 per cent of the population are supplied from this source. The Baker & Dearborn water-works were built in 1895, the source being a spring and Suncook river. The latter receives all the sewage of Pittsfield, sixteen miles above. This river water is pumped to three reservoirs, 150 x 20, 50 x 20, and 50 x 20, and 9 feet deep respectively. The distributing main is one mile in length and is of wrought iron; service pipes of galvanized iron. About 10 per cent of the population take water from this supply. There are many private wells within the circuit of these two supplies.

*Chemical Examination of Water from Various Sources.**

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
743	1902. Aug. 25	None	one	V. slight	0.0	5.80	3.80	.0006	.0014	.0300	.0000	.40	3.80	.....	g
744	Aug. 25	None	None	Slight veg.	1.20	6.20	2.00	.0010	.0190	.0200	.0000	.15	1.90	.....	g

*Sample No. 743 is from a faucet of Baker & Dearborn Water-Works; No. 744, from a faucet of the Suncook Water-Works.

Two analyses of water from one private source have been made. Water organically good, but carrying lead. See Nos. 142 and 332 in table of analyses.

PETERBOROUGH.—In 1896 the town installed a water supply from a brook fed by springs. The watershed is three miles by one mile in extent, consisting of pasturage and woodland. It is a gravity system of approximately four miles of distributing mains, iron; service pipes of iron. Two hundred or more families, one fifth of the population, are consumers. There are quite a number of wells still in use, but they are gradually being given up.

Chemical Examination of Water from Tap of Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
851	1902. Oct. 10	None	None	Decided veg.	0.4	6.30	1.80	.0000	.0062	.0000	.0000	.12	1.80	.....	g

The water from twenty other supplies was examined. Ten supplies were found to be of good quality and ten were bad. Of the ten bad supplies nine were so reported because they contained lead in dangerous quantities. For results see Nos. 31, 65, 82, 308, 449, 511, 512, 517, 536, 555, 557, 641, 642, 656, 667, 691, 695, 696, 776.

PIERMONT.—No public supply. Nearly all the water used in town is obtained from springs on the hillside of sand and sandy loam. There are only nine wells in town. Lead pipe is used chiefly.

PITTSBURG.—There is no other water supply in this town than springs and a very few wells. Nearly every family has spring water.

PITTSFIELD.—No public supply. The Pittsfield Aqueduct Company installed a supply from a pond in 1884. It is a gravity system. There are eleven miles of cement-lined iron mains, while the service pipes are of galvanized iron. Two hundred and seventy-five families, 95 per cent of the population, take of this water. There are a few private wells in use.

One well was examined and found to be unfit for drinking purposes. See No. 298 in table of analyses.

PLAINFIELD.—No public supply. A private supply was introduced in 1890-91 by the Meriden Water Company. The source of the supply is springs dug from seven to ten feet deep, and flowing from ten to thirty gallons per minute. The watershed has an area of about one hundred acres, all cleared. The water flows by gravity to a reservoir 20 x 25 x 8 feet, and having a capacity of 1,000 barrels. The distributing main is 1½ miles long, and this as well as the service pipes are plain iron. Twenty families, besides the hotel and boarding-house, are supplied from this source. There are many individual wells in the locality.

Chemical Examination of Water from Tap of Meriden Water Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
860	1902. Oct. 13	Marked	Much min.	Slight	0.1	10.00	5.00	.0000	.0000	.0000	.0000	.06	4.50	.....	g

PLAISTOW.—All of the water used in this town is obtained from individual wells.

One supply only has been examined at the State Laboratory of Hygiene, and that appeared to be slightly polluted, but was reported as probably suitable for drinking. See No. 530 in the table of analyses.

PLYMOUTH.—The town installed a system of water-works in 1880 and 1881, the supply being from springs and wells. The average depth of the wells is six feet. A foot of top soil is loam; below the loam is marl and gravel. The wells are dug. The water flows by gravity to two reservoirs having a capacity of 4,000,000 gallons; area, one acre; average depth, twelve feet. There are about six miles of distributing mains, one half cement, one half iron; service pipes are of galvanized iron. The average daily consumption is about 50,000 gallons. About three hundred families, 75 per cent of the population, are consumers. There are several individual wells in the locality.

Chemical Examination of Water from Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
627	1902. June 30	V. slight	None	Veg.	0 25	8.00	3.10	.0000	.0054	.0000	.0000	.10	2.30	.....	*
629	June 30	Slight	Slight	Veg.	0.26	7.80	3.10	.0006	.0084	.0000	.0000	.12	2.30	.....	†
630	June 30	Slight	Slight	Decided veg.	0.26	8.10	2.00	.0006	.0120	.0000	.0000	.07	1.90	.....	‡
631	June 30	Slight	None	Decided veg.	0.26	6.40	2.50	.0000	.0072	.0000	.0000	.07	1.90	.....	§

* Sample taken from faucet in mill. † Sample taken from Reservoir No. 1.
‡ Sample taken from Reservoir No. 2. § Sample taken from faucet in drugstore.

Samples from five private sources have been examined: one from tap, one from well, and three from springs. Three samples were of good quality; two were dangerously contaminated with lead. See Nos. 136, 626, 628, 659, and 722 in table of analyses.

PORTSMOUTH.—The city constructed a system of water-works in 1891, the source being wells and springs. The watershed is about four square miles in area, partly wooded; no inhabitants very near. The wells are driven from seventy to one hundred feet, in gravel. The water is pumped to a standpipe having a capacity of 500,000 gallons. There are about thirty miles of cast-iron distributing mains; service pipes are of galvanized iron. The average daily consumption is 1,500,000 gallons. Practically the entire population, 2,000 families, are consumers. There are very few private wells.

Chemical Examination of Water from Portsmouth Water Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
621	1902. June 27	None	Slight floc.	Slight aromat.	0.0	10.40	8.80	.0000	0018	.0150	.0000	.27	4.50	.....	g

Sample from one well has been examined, and reported unfit for drinking purposes. See No. 439 in table of analyses.

RANDOLPH.—No public water supply.

RAYMOND.—In 1893 the town installed a public water supply from a system of wells driven from forty to sixty feet deep, through loam, sand, and gravel. The water is pumped to a standpipe having a capacity of 118,037 gallons. The watershed is about one square mile in area, is about equally wooded and cleared, and on it are about six hundred inhabitants. The distributing mains, from three to four miles in length, are of iron; service pipes of galvanized iron. Eighty families, 80 per cent of the population, are consumers, the average daily consumption being 65,000 gallons. There are a few wells in the locality.

Chemical Examination of Water from Faucet of Raymond Water-Works.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
376	1902. Jan. 24	None	None	V. slight	0.0	11.90	8.50	.0010	.0064	.1900	.0000	1.62	4.20	.....	..

RICHMOND.—No public supply. Each family, as a rule, has its individual well. There is one well, however, that is owned by several neighbors for their own private accommodation, especially when other wells may be dry in summer. One hotel is supplied from a private well across the street, and from another in the hotel cellar.

One sample of water from this town was examined at the State Labor-

atory of Hygiene, and was found to be badly polluted. See No. 767 in the table of analyses.

ROCHESTER.—The Rochester water-works, owned by the city, installed in 1885, has for a source a pond and reservoir, the pond being about one hundred acres, and the reservoir two hundred acres in area. The water-shed, several square miles in extent, is both wooded and cleared, with, perhaps, seventy-five inhabitants. The water flows by gravity through from fifteen to twenty miles of cast-iron mains; service pipes nearly all iron, some are lead. More than 90 per cent of the population are consumers of this water. There are not many private wells in the locality.

Chemical Examination of Water from Tap of City Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
878	1902. Oct. 17	None	None	Slight veg.	0.15	5.70	1.00	.0000	0086	.0000	0000	.15	.90	.....	g

The water from eight other supplies has been examined, and four supplies found badly polluted; three were potable and one was of doubtful quality. For results see Nos. 311, 319, 470, 482, 485, 615, 660, 688 in table of analyses.

ROLLINSFORD.—No public water supply, the only source being wells and springs, samples from many of which have been analyzed at the State Laboratory of Hygiene, and in a majority of cases found to be unfit for domestic use. There are a number of citizens who would be glad to see a system of water-works installed in the village.

Twenty supplies at Salmon Falls, in the town of Rollinsford, have been examined, and fourteen of the number found to be unfit for use. Six supplies were of good quality. For results see Nos. 250, 251, 252, 253, 263, 264, 265, 266, 287, 313, 314, 333, 334, 431, 432, 433, 441, 483, and 484.

ROXBURY.—No public supply. Some families use the old wells, but most of them are supplied with running water from the hills.

RUMNEY.—This town is supplied with water from private wells and springs.

Of the eight samples examined at the State Laboratory of Hygiene, three were found to be potable, two were of doubtful quality, and three were unfit for drinking purposes. Of the three polluted supplies, one was condemned because it contained lead in large quantities. See Nos. 205, 215, 216, 280, 438, 681, 682, and 683 of the appended table of analyses.

RYE.—No public supply. The entire water supply is taken from private wells and springs.

Two supplies only were examined, and both proved to be pure. For results see Nos. 105 and 692.

SALEM.—No public supply. The Salem Water-Works Company are putting in a system of water-works from Policy pond, partly in Windham and partly in Salem. The pond has an estimated area of eight hundred acres, with an average depth of forty feet (estimated). It is fed by springs, no streams entering it, and the bottom is gravelly. The watershed has a gradual slope, partly wooded and partly pasture. The water flows by gravity. The present water supply of the town is from private wells.

*Chemical Examination of Water taken from Policy Pond, otherwise known as Canobie Lake.**

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
228	Oct. 27	None	Slight	Decided veg.	0.1	2.80	1.50	.0000	.0176	.0000	.0000	.21	1.20	.0000	g
229	Oct. 27	None	Slight	Decided veg.	0.1	3.00	1.20	.0000	.0192	.0000	.0000	.23	1.20	.0000	g

* Sample No. 228 was collected opposite Crosse's Grove; No. 229, opposite Chase's Grove.

Ten samples from private supplies, nine wells and one spring, have been examined. The spring had good water, two wells of doubtful quality, and seven bad. See Nos. 114, 115, 140, 199, 242, 358, 471, 515, 661, and 685 in table of analyses.

SALISBURY.—No public water supply.

Four supplies have been examined and all found bad. One supply was polluted by sewage, and three contained lead. For results see Nos. 163, 275, 693, 694.

SANBORNTON.—No public water supply.

SANDOWN.—No public water supply.

But one supply of this town has been examined, and that, a well, was polluted and unfit for use. For result see No. 602.

SANDWICH.—No public supply. Practically every house has its individual well. Some of the water is conveyed through lead pipe.

Two wells, one polluted and unfit for use and the other of permissible quality, have been examined. See Nos. 41 and 217 in table of analyses.

SEABROOK.—No public water supply.

The one supply examined was found to be very badly polluted. For result see No. 262.

SHARON.—No public supply. Water is obtained entirely from springs and wells.

SOMERSWORTH.—A system of water-works was installed by the city in 1895, from Salmon Falls river, which received the sewage of East Rochester and the woolen mills there. The water is pumped to a standpipe having a capacity of 997,000 gallons. The distributing mains are cast iron; service pipes, galvanized iron. The average daily consumption is 626,000 gallons. There are 850 connections, representing about nine tenths of the population. There are several private wells within the radius of this supply, but many who have wells have city water also.

Chemical Examination of Water from Faucet of City Water-Works.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
60	1901. July 11	None	None	Decided veg.	0.7	4.50	2.50	.0074	.0167	.0050	.0003	.33	1.80	.....	..
497	1902. May 5	None	None	Veg.	0.5	4.00	1.90	.0006	.0056	.0200	.0000	.15	1.20	.....	..
585	June 11	None	None	Slight veg.	0.55	6.60	1.50	.0000	.0092	.0200	.0000	.14	1.20	.....	..
647	July 14	None	None	Decided veg.	0.6	4.70	2.20	.0000	.0098	.0200	.0000	.14	1.80	.....	..
657	July 17	None	V. slight	V. slight	0.5	6.10	2.20	.0020	.0154	.0200	.0000	.15	2.20	.....	..
788	Sept. 9	None	None	Slight veg.	0.45	8.30	2.40	.0014	.0100	.0100	.0000	.15	2.40	.....	..

Many wells and springs have also been examined and, in a majority of cases, the water found to be unsuitable for drinking. For results see Nos. 61, 68, 391, 416, 527, 540, 547, 579, 580, 644, 645, 658, 673, 679, 680, 699, 700, 701, 702, 756, 757, 758, and 759.

SOUTH HAMPTON.—There is no public supply in town. Water for family use is all from wells. A few springs are used for barnyard and highway purposes.

SPRINGFIELD.—The water supply of this town is entirely from private wells and springs.

Of the two supplies examined at the State Laboratory of Hygiene, one was reported potable, and the other unfit for drinking. For results see Nos. 99 and 126 in the table of analyses.

STARK.—No public supply. Water is obtained from springs and driven wells.

STEWARTSTOWN, WEST.—No public supply. The Consolidated Water Company furnishes water to twenty-five families, the source being several springs and a few wells. Several shallow wells were dug on a hillside near the village, above which, and from thirty to fifty rods distant therefrom, are a few acres of wet, springy ground. The soil is a dark deposit, with gravel underneath. The quantity of water in the wells is not large. There is a reservoir of about 10,000 gallons' capacity, from which leads about one half mile of wrought-iron distributing main; service pipes are galvanized iron. There are still a few deep wells in the locality, dug from fifteen to twenty feet, on a level with the river, and which have good supplies of water.

STODDARD.—No public supply. Most of the families are supplied from individual wells; a few from Long lake.

STRAFFORD.—No public supply. Water is obtained from individual wells, the pipes used being partly lead and partly galvanized iron.

STRATFORD.—No public supply. The village of North Stratford has two private water supplies. In 1882 Mr. Clark Stevens installed a supply from a system of springs, the watershed being about sixty acres, mostly cleared land; no inhabitants. The springs are seven in number, stoned from five to seven feet deep. The top soil is loam, gravel below loam to bottom of wells. The water flows by gravity through about 1½ miles of galvanized iron mains; service pipes also galvanized iron. There

are two private wells within the circuit of this system. In 1888 Mr. J. C. Hutchins introduced a second supply, also from springs stoned about six feet deep, with same kind of soil as first supply. The watershed is about five square miles in area, mostly cleared land; no inhabitants. The water flows by gravity through three miles of distributing mains of galvanized iron; service pipes, galvanized iron. There are two private wells within the radius of this supply. About 98 per cent of the population are served from these two systems.

*Chemical Examination of Water of Stratford.**

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
800	1902. Sept. 11	None	None	None	0.0	5 80	2.20	.0010	.0030	.0150	.0000	.05	1.90	.....	g
801	Sept. 13	None	None	None	0.0	6.10	2.10	.0000	.0000	.0200	.0000	.05	2 00	.....	g

* Sample No. 800 was taken from faucet of J. C. Hutchins' water supply; No. 801, from faucet of Clark Stevens' water supply.

Stratford Hollow.—No public supply. Water is obtained from individual wells and springs.

Stratham.—No public supply. There is one private supply, pumped by windmill from a spring to an out-of-doors tank, from which four houses are supplied. The water supply of the town is chiefly from individual wells and springs. A few filtered cisterns are used.

Sullivan.—Individual wells and springs are the only water supply.

Sunapee.—The Sunapee water-works, owned by the town, were built in 1901, Sunapee lake being the source from which water is taken to supply the Sunapee village, and Ledge pond for George's Mills. Water from the pond flows by gravity, while that from the lake is pumped to a reservoir of 300,000 gallons' capacity. There are about three miles of 4-inch, 6-inch, and 8-inch iron distributing mains; service pipes, inch and $\frac{3}{4}$-inch, are of galvanized iron. The average daily consumption, by fifty families, is 30,000 gallons. There are many private wells within the circuit of these supplies. The Lake Sunapee Water Supply Company, a private company of twenty-three stock owners and takers, in-

stalled its works in October, 1886. The water is taken from Sunapee lake, and flows by gravity. The plant is nearly worthless at this time, as the pipes are of small size and filled with rust.

Chemical Examination of Water from Lake Sunapee.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
306	1901. Dec. 4	Slight	Much floc.	Decided veg.	0.6	3.00	1.80	.0000	.0094	.0000	.0000	.08	1.50	.0400	*g
823	1902. Sept. 22	None	Slight	Slight musty	0.1	3.50	.60	.0000	.0112	.0000	.0000	.67	.60	.....	†g
824	Sept. 22	None	V. slight	Decided veg.	0.15	3.40	.70	.0000	.0090	.0000	.0000	.10	.60	.....	‡g

* Sample taken from private supply through 150 feet of lead pipe.
† Sample taken from Ledge Pond, George's Mills water supply.
‡ Sample taken from Lake Sunapee, supply of Sunapee Water-Works Company.

Of the four private supplies examined, one was of doubtful quality, and three were suitable for drinking. For results see Nos. 240, 273, 496, and 651 in the appended table of analyses.

SURRY.—No public supply. Water is obtained from wells dug about three feet deep, on a hillside, and are fed by springs. The water flows by gravity about one mile, through lead pipe. Fourteen families are so supplied.

SUTTON.—The water used in this town is obtained from private wells and springs. Some wells are near buildings, and pumps are used; in other cases the water is conducted through lead pipes from springs back in the hills.

Samples from twelve supplies have been analyzed at the State Laboratory of Hygiene, of which nine were found to be badly polluted; one was of doubtful quality; and the two others, which contained slight amounts of lead, were reported as doubtful. Two of the polluted waters were so reported because of the large amount of lead they contained. For results in detail see Nos. 14, 67, 169, 195, 302, 318, 329, 490, 493, 549, 639, and 678 in the table of analyses.

SWANZEY.—No public supply. A private supply at West Swanzey furnishes water for four or five families from a small reservoir fed by springs, but the water is not used to any extent for drinking.

The one supply examined was somewhat polluted, but was probably safe. For result see No. 690.

TAMWORTH.—No public supply. Water is obtained from individual springs and wells.

TEMPLE.—No public and no private system of water-works. Water is obtained from individual springs, which flow by gravity, and from wells.

THORNTON.—No public supply. Water is obtained from springs and wells, through lead and iron pipes.

TILTON.—No public supply. A private supply was installed by the Tilton & Northfield Aqueduct Company in 1887-88, the source being a pond of about sixty acres in area, from ten to seventy-five feet deep; sand and gravel bottom, with but very little mud. The watershed is several hundred acres in extent, wooded and pasture, with five farms. The water flows by gravity, through about ten miles of distributing mains, cement lined and cast iron; service pipes of galvanized iron chiefly. Four hundred or more families, 75 per cent of the population, are users. There are still a very few wells in the locality, most of them having been abandoned.

Chemical Examination of Water from a Faucet in Tilton Supplied by the Tilton & Northfield Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
11	1901. May 28	V. slight	Slight	Distinct veg.	0.2	3.40	1.30	.0019	.0150	.0000	.0000	.09	.....	.....	g
345	Dec. 31	None	None	None	0.2	2.90	1.20	.0044	.0136	.0056	.0000	.09	.90	.....	g

Samples from three wells have been examined: two were pronounced good, and one bad. See Nos. 109, 123, and 677 in the table of analyses.

TROY.—No water supply other than individual wells and springs.

Of four samples examined at the State Laboratory of Hygiene, two were condemned because of the large amount of lead they contained. For results see Nos. 210, 276, 277, and 601 in the table of analyses.

TUFTONBOROUGH.—No public supply.

UNITY.—No public water supply. The people are supplied with water chiefly from wells. A few have running water from individual aqueducts. It is believed that many of the wells furnish poor water.

One spring supply was found to contain a large amount of lead. For result see No. 776.

WAKEFIELD.—No public supply. There are two driven wells in town; the others are dug and are not more than fifteen to twenty feet deep, on an average.

Six samples of water from this town have been examined at the State Laboratory of Hygiene, of which five were pronounced good and one of doubtful quality. See Nos. 632, 635, 636, 654, 792, and 793 in the table of analyses appended.

WALPOLE.—The North Walpole Village Precinct Water-Works, owned and managed by the precinct named, was installed about thirty-five years ago by Nathaniel Monroe. There are four springs; one, flowing twenty-five gallons per minute, is pumped to a reservoir; three others run into cement-lined pipes and supply eighty-four families, and have a capacity for thirty more. The soil is fine gravel. There are about six miles of iron and cement mains, while the service pipes are lead and iron. Two hundred and forty families are supplied from this source. There are a few wells in this precinct. The remainder of the town of Walpole is supplied from private wells and springs.

Samples from two wells and a cistern have been examined. The cistern water was reported acceptable for drinking; the two well waters as polluted and unfit to drink. For detailed results see Nos. 171, 481, and 1621 in table of analyses.

WARNER.—No town supply. In 1895 a supply was introduced by private parties, which was later purchased by the Warner Village Fire District. This consists of a reservoir supplied by springs and a brook. The bottom is clayey hardpan in part, and part gravel; average depth, eight feet. The watershed is estimated at four hundred acres, wooded; not more than twelve inhabitants. The volume of water varies greatly. During the last drought the stream became dry, but the springs afforded sufficient water for all purposes. The water flows by gravity. There are four miles of cast-iron mains, while the service pipes are of galvanized iron. The supply is not metered. Sixty families, approximately 40 per cent of the population, are consumers. There are quite a number of private wells in the locality. There are many private supplies which are piped from springs long distances through lead pipe.

An examination of several of these waters has shown lead present in greater or lesser quantities. For detailed results see Nos. 12, 13, 518, 522, 675, 717, 731, 732, 754 in the table of analyses.

Chemical Examination of Water from a Faucet of the Village District Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
754	1902. Aug. 29	None	None	V. slight	0.3	5.30	2.00	.0000	.0110	.0000	.0000	.10	1.50	.....	g

WARREN.—No public supply. There are two private systems of water-works in town: one, the Warren water-works, was built in 1873, the source being a spring about a mile distant. The water flows by gravity through galvanized iron pipe. Nineteen families are supplied from this source. The other supply, the H. N. Merrill water-works, was installed about the year 1895. This supply is from a spring, and driven well 474 feet deep. The water flows partly by gravity and partly by being pumped into a reservoir. The distributing main, iron, is about a mile in length; service pipes galvanized iron. Eighteen or twenty families take from this supply. There are not many private wells within the radius of these supplies.

Chemical Examination of Water from Various Sources.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
875	1902 Oct. 17	Slight	Fine	V. slight	0.1	7.20	2.60	.0000	.0110	.0000	.0500	.09	1.95	.....	g
877	Oct. 17	None	None	Slight veg.	0.1	6.50	2.70	.0000	.0038	.0000	.0000	.10	2.70	.....	g

*Sample No. 875 is from H. N. Merrill Water-Works; No. 877, from Warren Water-Works.

One well and one spring have been examined. The well was pronounced bad; the spring of excellent quality. For results see Nos. 131 and 132 in table of analyses.

WASHINGTON.—No public water-works. The town being quite hilly, a great many families have put in private aqueducts at comparatively small expense. It is probable that nearly or quite half the farms have aqueducts supplying house, or barn, or both. Lead pipe has generally been used to conduct the water, although of late iron pipe has been employed to some extent.

Four samples, one from tap, three from wells, have been examined. Three were reported unfit for use; one permissible. See Nos. 5, 176, 191, 609 in table of analyses.

WEARE.—No public water supply. Four families at Riverdale are supplied from a spring, by lead pipe. The works were put in about sixty years ago by Christopher Simons, who supplied the village with excellent water. Later, the owner of the spring asked several parties to put their faucets on a level with his; they would not. He cut the pipe and laid a new line to supply the four families mentioned. The others now depend upon wells. At North Weare four families get water from a spring, through pipe not lead. Wells are generally used, although quite a number in town have running water from springs.

Two spring supplies, the Mineral spring at North Weare, and Cold spring at South Weare, were of excellent quality. One well examined was found to be polluted. For results see Nos. 75, 139, and 243.

WEBSTER.—No public water supply. Water is supplied by private works from springs and wells.

One private supply has been examined and found to be excellent in quality. For result see No. 445.

WENTWORTH.—There are no public water-works in town. The supply is from wells and springs.

WESTMORELAND.—No public supply.

WHITEFIELD.—The public water-works, owned by the town, were built by private parties in 1892. The water is from streams, and flows by gravity to a reservoir having a capacity of 800,000 gallons. There are two watersheds of about thirty acres each. There are about 3½ miles of distributing mains, cast iron; service pipes of galvanized iron. About three hundred families, 75 per cent of the population, are consumers. The remainder obtain water from individual wells.

Chemical Examination of Water from Town Supply.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
861	1902. Oct. 14	None	Slight floc.	Veg.	0.0	5.00	1.50	.0000	.0026	.0000	.0000	.04	1.50	.....	g

One well supply was examined and found to be unfit for use. For results see No. 108 in table of analyses.

WILMOT.—No public and no private water-works. The supply of this town is from individual springs or wells.

WILTON.—No public supply. There are two small private supplies from springs, in both cases dug not over eight or ten feet deep, through sand or gravel; some clay in spots. Water flows by gravity less than a mile, through lead service pipes and main. About twenty-five families are so supplied. This town is situated in a valley, and the hills all around are full of excellent water. Most of the houses are supplied from individual springs. All are shallow, from six to ten feet deep.

Water from fourteen of these springs has been analyzed, and of that number but four were found suitable for drinking. Of the ten polluted supplies, five contained lead in greater or lesser amounts, sufficient to condemn them. For detailed results see Nos. 122, 180, 197, 209, 244, 288, 310, 350, 475, 487, 553, 582, 612, 618, 730 in the table of analyses.

WINCHESTER.—No public water supply.

WINDHAM.—No public supply.

WINDSOR.—No public supply. Most of the water is taken from wells dug from fifteen to twenty feet; soil mostly heavy loam; subsoil, clay or hardpan. One well, twelve feet deep, is through light soil, gravel subsoil. One spring is about three feet deep; soil same as last. Nearly all the water is drawn with copper pump through lead pipe. One is supplied by gravity through lead pipe, and one by open bucket.

WOLFEBOROUGH.—The public water-works, owned and operated by the town, were installed in 1889. The source of the supply is a pond of about three hundred acres; depth in places from sixty to seventy feet; average

for the pond about thirty-two feet; bottom mostly sand, with small rocks. The watershed is from three to four square miles in extent; five sevenths woodland, two sevenths pasture; only one family inhabits the watershed. The pond is fed by several large springs, with large and constant flow. The water flows by gravity through 14.69 miles of distributing mains; 9⅛ miles cast iron; 5½ miles wrought iron. Service pipes are mostly of galvanized iron. About 1,200 persons, 557 faucets, are supplied from this source. There are, perhaps, twenty private wells within the circuit of this supply.

Chemical Examination of Water from Public Fountain.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
842	1902. Oct. 9	None	None	Slight musty	0.0	3.90	1.40	.0000	.0068	.0000	.0000	.07	1.30	.....	g

Three other supplies were examined, of which two were bad and one was good. For results see Nos. 35, 36, 37.

Woodstock.—In 1897 the North Woodstock Water Company installed a system of water-works, which was sold to the town of Woodstock. This is in the precinct of North Woodstock. The source is a stream dammed to form a reservoir of about one acre. The water flows by gravity through 2¾ miles of cast-iron mains; galvanized iron service pipes. The average daily consumption is about 8,000 gallons, not including summer hotels. Seventy families, 99 per cent in the precinct, are takers. There are no wells in the precinct. The town of Woodstock is about evenly divided into the northern and southern portion. The latter is supplied with water from private wells and springs, and since the removal of all lead pipe, etc., it seems to be of good quality.

Woodsville.—Woodsville Fire District is supplied with water by the Woodsville Aqueduct Company, whose plant was installed in 1885, by James Gordon, who introduced water from Gordon spring in 1892 or 1893. The first-named supply is from Ammonoosuc river, which receives all the sewage from the towns of Bath, Lisbon, and Littleton, farther up the river. The water is pumped directly from the river and flows through about three miles of distributing mains, iron. This company also sup-

plies water from a spring, dug about four feet deep, which yields about 50,000 gallons daily, delivered through two miles of lead pipe. Soil is mucky loam, with sandy bottom. About nine tenths of the population are supplied from these sources. Gordon spring is about two feet deep, while the volume of water is about 48,000 gallons daily; soil, mucky loam, with sandy bottom. One half mile of galvanized iron pipe is used to convey this water. Thirty-three families take from this supply. There are twelve or fifteen driven wells in the locality.

Chemical Examination of Water from Supply of Woodsville Aqueduct Company.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
	1901.														
17	June 3	None	Cons. floc.	Slight veg.	0.1	3.60	1.20	.0014	.0057	.0066	.0000	.13	.....	.....	*g
18	June 3	None	Much floc.	Slight veg.	0.1	4.10	1.70	.0046	.0093	.0066	.0000	.13	.....	.....	†g
19	June 3	None	Slight	Slight veg.	0.1	3.70	2.20	.0004	.0057	.0066	.0000	.13	.....	.....	‡g
57	July 9	None	Floc. veg.	Decided veg.	0.12	5.00	2.00	.0009	.0104	.0050	.0002	.26	2.00	.....	†g
58	July 9	None	None	Veg.	0.10	4.70	2.10	.0032	.0104	.0050	.0002	.20	.....	.....	‡g
59	July 9	None	Much floc. veg.	Decided veg.	0 12	4.70	2.20	.0032	.0135	.0050	.0002	.20	.....	.....	*g
159	Sept. 12	None	None	Decided veg.	0.15	5.10	3.30	.0016	.0112	.0000	.0000	.19	.....	.....	‡g
160	Sept. 12	None	Floc. veg.	Decided veg.	0.15	5.60	2.60	.0026	.0126	.0000	.0000	.19	.....	.....	†g
	1902.														
404	Feb. 13	None	V. slight	Veg.	0.1	5.80	3.40	.0006	.0070	.0200	.0000	.10	1.60	.....	†g

*** Sample taken from intake, Ammonoosuc River.**
† Sample taken from tap at Thayer's house. ‡ Sample taken from tap at Whitcher's store.

This water is somewhat polluted by the sewage which enters the Ammonoosuc river above Woodsville, at Bath, Lisbon, and Littleton. The amount of sewage present is somewhat greater during the summer and fall, when the flow of water is the least. Samples taken during the winter months show but slight pollution.

LEAD POISONING AS RELATED TO WATER SUPPLIES.

Lead pipe has been always a favorite medium for conveying water from the supply to the consumer, because of the ease with which it can be made, its resistance to corrosion, and its adaptability to use. The supplies of Rome were frequently conducted through lead, and specimens of the pipe they made two thousand years ago are still in existence and capable of service.

The one great objection to the use of lead pipe is that it is somewhat soluble in certain waters, and lead, when taken into the system, acts as a cumulative poison. Lead poisoning is a complaint which may imitate almost any other complaint, and it is a practical point to know that it is common in New Hampshire, doing immense damage to health, but very generally unrecognized and unsuspected.

Acute lead poisoning, as manifested by lead colic, anæmia, paralysis, epilepsy, etc., is rarely met with as a result of the use of leaded waters, but the insidious forms of plumbism, or lead poisoning, which are very much more common than the acute cases, are constantly with us. The effects produced by the small amounts of lead taken into the system are rarely so serious as to cause death, and for this reason the injurious results of the long-continued use of waters so polluted are only gradually receiving recognition. As lead poisoning is not often registered as a primary cause of death it does not make a show in the death list, but there is no doubt that the death rate is increased by its prevalence. But even if no death could be ascribed to lead poisoning, the amount of pain, suffering, and misery caused is widespread and can only be appreciated by the sufferers. It is believed by those who are lucky enough to escape, that the risks of this kind of poisoning are exaggerated. The contrary is quite the case.

The indications of chronic lead poisoning, such, for example, as are liable to ensue after the continuous use of water containing small quantities of lead, are as follows: The symptoms are usually slow in their progress; there is generally anæmia, with a consequent anæmic pallor of the skin; there is often constipation and indigestion; there may be a loss of appetite, an unquenchable thirst, a constant unpleasant metallic taste in the mouth, and a foul odor in the breath; the countenance becomes dull and appears anxious; there is rarely any fever and the pulse is usually natural; the respiration is often rapid; there is frequently abdominal hardness and pain, the pain increasing as the case progresses, colic being the most common symptom.

Occasionally lead paralysis is manifested; the upper extremities, and especially the extensor muscles, are most commonly attacked, those of the

wrist and forearm suffering first. The chief diagnostic sign is the blue line upon the gums at the margin of the teeth, due to the formation in the capillaries of the gum of sulfid of lead. This blue line is by no means always present, however. The presence of lead in the urine constitutes a valuable diagnostic symptom. In mild cases the prognosis is usually favorable when the exciting cause has been removed; but in severe cases, and especially where paralysis exists as a consequence of lead poisoning, the injury may be permanent, and occasionally prove fatal.

The State Board of Health of Massachusetts* has been very active in the investigation of lead poisoning and its results are conclusive. The city of Lowell has been closely connected with the investigation, as the ground water of that city dissolves lead in dangerous quantities, and, as a consequence, lead poisoning has always been prevalent there. In 1899 an investigation disclosed an alarming condition of affairs, with many acute cases of a very serious nature, and, as a result of the investigation, the old supply was abandoned and a new one secured. Many valuable facts were brought out in the investigation. Wrist drop, constipation, and marked debility were the most common symptoms, and were produced by the use of water containing as little as .01 part of lead per 100,000. When the use of the water was discontinued and the proper remedies applied, the patient usually made a good recovery.

During the past year we have been frequently called upon to examine waters for the presence of lead, and the frequency with which it was found prompted us to examine all waters for lead where there was any reason to think that the water had flowed through lead pipe.

Samples of water from 177 supplies were examined for lead and in 135, or 76 per cent, of the cases it was found to be present. These results had such an alarming significance that it was thought best to make special investigations of all the cases where lead was found. It was decided to call upon the physicians of the state for their assistance and the following letter was sent to those who had collected samples of water containing lead:

LABORATORY OF HYGIENE,

CONCORD, N. H., ...

DEAR DOCTOR,—Since the work at the Laboratory of Hygiene on waters which are conveyed through lead pipe shows lead present in over 50 per cent of such waters, and as in many cases lead poisoning has resulted from the use of the waters, it seems advisable to investigate more thoroughly each case where we have found lead present.

In this work we rely on your co-operation, and trust you will furnish us such facts as seem of importance.

*Report of the State Board of Health of Massachusetts in 1899, page xxxi.

Some time ago we found that a sample of water collected by you from the supply of ..... contained lead to the amount of ..... parts per 100,000.

Can you ascertain whether any ill effects had been noticed by persons habitually using the water? And, if so, will you describe any symptoms of lead poisoning, such as the blue line on the gums, lead colic, wrist drop, etc., that you have observed?

Have you treated any patients for lead poisoning, and with what results? Has the disuse of water containing lead resulted in an improvement in the health of persons who have had symptoms of lead poisoning?

Any other facts concerning cases of lead poisoning from the use of leaded waters will be of much value to us.

Thanking you in advance for the information you may give us, I am,

Yours very respectfully,

H. E. BARNARD,
Chemist.

The response to our application was most gratifying, and from the many communications received the following letters are selected as showing very clearly the usual symptoms observed in cases of lead poisoning, the severity of the attacks, and the treatment employed.

FRANKLIN FALLS, N. H., July 5, 1902.

H. E. Barnard, Chemist Laboratory of Hygiene:

DEAR SIR,—Your letter asking for information regarding lead poisoning from water collected by me received. The sample sent was numbered 411 and contained .022 parts of lead per 100,000. This was from a spring in which I have one fifth interest, and comes to my house. This spring water has been used by five families without any apparent trouble, but I used it only a short while when I began to detect symptoms of lead poisoning, and I myself was the victim. I then sent the water to the laboratory, with the result of which you have a record.

I have under my treatment at the present time four cases. In one case colic is quite frequent, wrist drop and bleeding from the nose; in another, very marked neuritis, also involving the extensor muscles. The others do not vary from the ordinary.

Disuse of the water and treatment show rapid improvement.

It is very singular that in families of four or five only one shows any symptoms of lead, while they all use the same water.

In the cases which came under my observation, the first symptom to disappear was severe colic.

Respectfully,

A. A. BEATON, M. D.

MILFORD, N. H., June 9, 1902.

H. E. Barnard, Chemist, Concord, N. H.:

DEAR SIR,—Replying to your favor of June 7, asking for information concerning samples Nos. 92, containing 1.7 parts, and 130, containing but .004 parts of lead per 100,000, both samples came from waters which were habitually used for drinking and cooking purposes. In both cases I was called upon to treat patients for what I believed to be lead poisoning. This led

me to have the waters analyzed by you, and you confirmed my diagnosis. The patients exhibited the usual symptoms of lead poisoning, viz., blue line on gums, cramp pains, constipation, wrist drop, etc. The use of the water was discontinued and the usual remedies given, and good recoveries resulted in each case.

Very truly,
H. S. HUTCHINSON, M. D.

ANDOVER, N. H., July 4, 1902.

H. E. Barnard, B. S.:

DEAR SIR,—In reply to your letter of June 10, concerning case of lead poison from use of water No. 477, containing .54 parts of lead per 100,000, I will report as follows:

One man was sick from lead poisoning. There can be no mistake in diagnosis. I have had one other case of lead poisoning from use of water containing lead. Both cases have nearly recovered. One case had blue lines on the gums, together with very severe colic. The use of the water was abandoned as soon as lead poisoning was suspected. I have treated other cases in years past.

Respectfully,
H. A. WEYMOUTH, M. D.

MILFORD, N. H., June 11, 1902.

H. E. Barnard, Chemist Laboratory of Hygiene:

DEAR SIR,—Replying to yours of the 7th inst., I will say I treated a patient in Hancock who had been using the water sent for analysis. He had lead colic. Disuse of the water and treatment produced relief from cramps, from which he had been an occasional sufferer for some time.

Yours truly,
E. H. TAFT, M. D.

Dr. Taft writes at greater length under later date, as follows:

MILFORD, N. H., September 12, 1902.

H. E. Barnard:

DEAR SIR,—In regard to cases of lead poisoning, I have sent three samples of water for analysis which proved to be contaminated with lead. In the families using the water were two persons suffering from marked colic and slight abdominal pains, with stomach trouble simulating carcinoma. Their troubles began to disappear when use of the water was stopped and appropriate treatment begun. In another family one patient had colic, another had colic and rheumatism and headache. These two were the women of the family. The men who drank less of the water had slight gastric troubles. Improvement in every case followed when a new water supply was procured.

Another case had been drinking the water for five years with increasing stomach trouble. These are all my cases up to date.

Yours,
E. H. TAFT, M. D.

KEENE, N. H., July 16, 1902.

H. E. Barnard, B. S.:

DEAR SIR,—Your letter of last month is before me and I regret that I have been unable to answer it earlier. In regard to the family who were using

the water, numbered 521 in your laboratory, which you examined and found to contain 3.3 parts of lead per 100,000, I can state that a decided improvement in the patient's condition was soon noticed after withholding this water as a source of supply for drinking purposes. This improvement has remained permanent. This patient began using the water in August, 1901, and in two months had a slight attack of colic. In December he had an attack of abdominal pain of a colicky nature for three days, combined with constipation, but he continued to work. In January, 1902, another attack about the same, except that the constipation was more severe. In March he had a more severe attack and called for medical aid. I found a man of about twenty-five years of age, anæmic, with severe abdominal pain, a little temperature, and badly constipated. He was in bed five days, and all symptoms except anæmia improved. In April I was called again and found him in a similar condition, except pain more steady and intense and a blue line on the two lower middle incisors. He was in bed eight days, feeling better as soon as bowels were freed. He is now in good condition, with a good color, no constipation, and says he feels as well as he ever did in his life. It is interesting to note that his wife had two attacks of colic and was constipated. His child of three years slowly became constipated and was slowly losing color. A baby born in February was slightly constipated at first but slowly contracted an obstinate constipation, especially after it began to take water between its feedings. Mother and two children are nicely, good color, and bowels acting normally.

I take this opportunity to thank you for the work done, and assure you it has been a great help to me in relieving this family.

Most respectfully yours,

JOHN D. PROCTOR, M. D.

NEWPORT, N. H., June 13, 1902.

H. E. Barnard, Chemist:

DEAR SIR,—In reply to your request for a clinical report of the case which prompted me to send you a sample of water to be analyzed for lead, and which you found to contain 1.1 part of lead per 100,000, I have to say that the patient is the sole user of the water, and she has wrist drop and partial paralysis of the hands and legs. No blue line on gums has yet been noticed.

Mrs. B. B. has been sick for some time and her case has been diagnosed by other physicians as cancer of the stomach, etc., etc.

The water is not being used at present.

Yours fraternally,

H. L. STICKNEY, M. D.

TROY, N. H., June 19, 1902.

H. E. Barnard:

DEAR SIR,—Replying to your recent communication regarding lead in water and its symptoms as observed, will say that I have had quite an experience with cases of lead poisoning, having had a large number of cases during my practice here. The water from which sample was sent you last fall supplied five families, some members in each of which were complaining of headaches, dyspeptic symptoms, rheumatic pains, constipation and diarrhea; but none had the wrist drop, or obstinate constipation, or lead colic. The sample I sent this week I found to contain lead, and Mrs. H has been complaining of pain in her feet and limbs with backache and some pain in

arms. I put her upon treatment and she is now nearly free from pain. All of these persons improved in health as soon as they left off the use of the water.

M. T. STONE, M. D.

FRANKLIN, N. H., June 9, 1902.

DEAR MR. BARNARD,—Referring to your analysis of water from a tap, numbered 76, which showed lead to be present to the extent of .015 parts per 100,000, I can state that a person using the water suffered from lead colic. Since leaving off using the water he has been much better. There was no blue line on gums or wrist drop.

Very truly yours,

E. T. DRAKE, M. D.

Under a later date Dr. Drake writes concerning another case: "The lady of the house where I took this sample has symptoms of lead poisoning, and I shall of course discontinue the use of the water and report later concerning results."

MARLBOROUGH, N. H., June 13, 1902.

H. E. Barnard, Concord, N. H.:

DEAR SIR,—With regard to laboratory No. 463 and No. 561, containing respectively .028 parts of lead per 100,000 and .013 parts of lead per 100,000, I would say that those using the water had slight symptoms of lead poisoning, such as colicky pains. When they ceased to use the water, these symptoms disappeared.

Yours truly,

W. H. ALDRICH, M. D.

MARLOW, N. H., September 20, 1902.

Mr. H. E. Barnard:

DEAR SIR,—Yours of September 17 received. I will give you what information I can and refer you to —— —— under whose direction we sent the water and who pronounced Mrs. G's trouble lead poisoning. The water pipe had been down seventeen years, and no trouble was observed, so far as we know, until about five years ago Mrs. G began to be troubled with numbness and pain in the right hand. Several doctors were consulted and decided that she was suffering from nervous trouble and rheumatism. However, they failed to benefit her till Dr. C told her to stop using the water. Since then she has been much better.

Yours respectfully,

G. F. G.

NEW HAMPTON, N. H., June 10, 1902.

Prof. H. E. Barnard, Concord:

DEAR SIR,—Yours of recent date is at hand. I remember but one case of lead poisoning, and that a rather recent one, which seems to have its origin in leaded water. This was an aged woman who was afflicted with rheumatism, which made it difficult to determine how much of her trouble was due to lead. She had had, some years before, what was diagnosed as lead poisoning and treated accordingly, with recovery. While under my care she has had some colicky pains in the abdomen, with constipation, but no blue line upon the gums was discovered. She discontinued the use of the suspected water and the pains disappeared under treatment, but wrist drop, which was quite marked, persists.

Yours very truly,

ALBERT A. DOLLOFF, M. D.

In addition to the communications from physicians the following cases are of interest in showing what slight amounts of lead are necessary to produce lead poisoning:

Case No. 122. Indications of lead poisoning; .24 parts of lead per 100,000. No. 142. Marked case of lead poisoning. Total paralysis of lower limbs. Lead in urine. There were .21 parts of lead in the water per 100,000. No. 144. Case of lead poisoning; 1.1 parts of lead per 100,000. No. 196. Paralysis, limbs below knees give out, liable to drop anything from hands, colic pains, no lead line; .16 parts of lead per 100,000. No. 202. Lead poisoning; .16 parts of lead per 100,000 in the water. No. 225. Numbness and weakness of limbs below the knees; .055 parts of lead per 100,000. No. 240. Hands swollen and painful; .008 parts of lead per 100,000. No. 306. Hands and arms numb; .04 parts of lead per 100,000 in the water used,—and so on through the list.

Referring again to the summary of results of analyses, it appears that in *seventy-four* cases the result of the examination corresponds with the diagnosis of the physician or the fears of the consumer of the water. In *forty-two* cases lead was suspected but was not found, and in *thirty-nine* cases it was found where it was not suspected.

In 117 cases where lead was present in quantities varying from .004 to 3.3 parts per 100,000 in 64, or practically 55 per cent of the cases, marked symptoms of lead poisoning developed in the users of the water.

Natural waters rarely contain lead, and probably never in a sufficient quantity to produce any evil effects; but certain waters, both hard and soft, containing very little or no alkaline carbonates, dissolve traces of the metal when conveyed through lead supply pipes. A careful and complete investigation of the effects of different waters on lead pipe has been recently carried out at the laboratories of the State Board of Health of Massachusetts, and their results show that in most cases the clear and practically colorless supplies containing the most free carbonic acid and a small or medium amount of mineral matters, as shown by the hardness of the water, are the ones which most actively attack lead. Certain mineral matters, such as chlorine, silica, and calcium carbonate, prevent action not only by forming a coating on the pipes but by their simple presence in the waters. It will be seen by these investigations that the purer and softer a water the greater its solvent action on lead.

New Hampshire springs and surface or shallow well waters are exceptionally pure in their original condition, carrying few solids and having a low hardness. They are thus more energetic in their action on lead than if of a lesser degree of purity, and while the user has the satisfaction of drinking sanitarially pure water he runs the greater chance of charging his system with lead.

When lead pipe is in use great care should be taken that the water is

not allowed to stand in the pipes, but is delivered to the user in a constantly flowing stream. If, however, it is impossible to allow the water to flow continuously, the pipes should be emptied before drawing water for use.

In no case coming under observation had the water stood in the pipes for any length of time, and all lead dissolved had been abstracted during the continuous passage of the water from its source to the tap or barrel from which it was drawn. If the water had stood in the pipes much greater amounts of lead would have been found. In cases which we have noticed, water on standing in pipes over night contained from two to twenty times as much lead as was found in the running water. In many observed cases of lead poisoning it has been found that the patient had been in the habit of drawing off water in the morning for drinking without first taking the precaution of emptying the pipes of the water which had been standing in them during the night. But even when the water is running constantly, results obtained at our laboratory, and elsewhere, show that varying amounts of lead will be dissolved, and may in time so charge the system of the user that positive ill effects are observed.

The amount of lead necessary to impair health cannot be determined definitely. The greatest variations are observed in individuals, and where in one case a large quantity of lead will produce no apparent ill effects, in another case the minutest quantities may in time cause lead poisoning.

The fact that waters from lead service pipes have been in use for years with no resulting sickness in the user is no reason for supposing that there never will be trouble. The systems of those who drink it may not be responsive to small quantities, but if there is constant accumulation the danger line may be reached and serious results follow.

The problem of eradicating lead poisoning from this state is a most difficult one. The remedy would seem to be a substitution of the lead service pipes by other kinds of pipe which are not readily acted upon by the water. In many cases, however, the cost of changing from lead to suitable pipe is prohibitive, and the abandonment of the supply would mean a return to the sewage polluted well. It has been suggested that the addition of small quantities of lime to the water will prevent solution of the lead, and by forming an insoluble coating of carbonate of lime on the inside of the pipe, protect it from further attack.

*It is also stated that filtration through animal charcoal is a means of removing the greater portion of any lead suspended or dissolved in the water. Such filters must of necessity be renovated from time to time.

In any case where lead pipe is used as a conveyer of water for drinking and domestic uses, the water should be examined, and if lead is found in any quantity the supply should be brought through some form of iron pipe or shut off entirely.

* Examination of Water, Leffman, page 118.

EXAMINATION OF WATER AND ICE.

During the winter of 1901-1902 it seemed advisable to examine samples of ice taken from various supplies in the state. At the same time analyses were made of water taken from the same sources. In every case the ice was of much better quality than the water from which it was formed, and in no instance was the ice unfit for use, although taken from water abnormally high in organic content.

Ice from Black Brook, Maxwell's Ice Field, Manchester.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
323	1901. Dec. 12	None	None	Decided veg.	1.0	4.50	2.40	.0050	.0600	.0000	.0000	.07	.70	.....	..
325	Dec. 12	None	None	None	0.0	1.40	1.40	.0000	.0082	.0000	.0000	.01	.00	.....	..

Ice from Black Brook, Stearns Brothers' Ice Field, Manchester.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
324	1901. Dec. 12	None	None	Decided veg.	0.9	5.80	2.50	.0050	.0580	.0000	.0000	.11	.60	.....	..
326	Dec. 12	None	None	None	0.0	2.30	1.20	.0010	.0046	.0000	.0000	.01	.00	.....	..

Ice from Massabesic Lake, Manchester Coal & Ice Co.'s Field, Auburn.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
365	1902. Jan. 20	None	None	None	0 0	2.50	.60	.0042	.0056	.0000	.0000	.02	.00	.....	..
369	Jan. 21	None	None	Decided veg.	0.8	5.70	1.20	.0054	.0204	.0000	.0000	.12	.....	.....	..

Ice from Nutt's Pond, L. B. Bodwell & Co.'s Ice Field, Manchester.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
366	1902. Jan. 20	None	None	None	0.0	3.00	.00	.0080	.0130	.0000	.0000	.03	.00	.....	..
373	Jan. 21	None	None	Decided veg.	0.7	7.20	2.20	.0052	.0230	.0200	.0002	.45	1.40	.....	..

Ice from Meadow Flowed for Ice, Sinclair & Fellows' Ice Field, Manchester.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
367	1902. Jan. 20	None	None	None	0.0	3.80	.80	.0064	.0136	.0000	.0003	.05	.00	.....	..
374	Jan. 21	None	None	Decided veg.	0.5	6.50	1.70	.0024	.0100	.0000	.0000	.19	1.10	.....	..

Ice from Meadow Flowed for Ice, West Manchester Coal & Ice Co.'s Field, Goffstown.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
368	1902. Jan. 20	None	None	None	0.0	3.10	.20	.0044	.0084	.0000	.0001	.02	.00	.....	..
375	Jan. 21	None	None	Decided veg.	0.2	4.50	1.70	.0010	.0098	.0000	.0000	.17	1.40	.....	..

Ice from Horseshoe Pond, Field of Concord Coal & Ice Co., Concord.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
405	1902. Feb. 14	None	Coal and sand	None	0.0	1.80	.40	.0034	.0024	.0000	.0001	.04	.00	.....	..

Ice from Fort Eddy, Merrimack River, Concord, N. H.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
406	1902. Feb. 14	None	None	None	0.0	2.40	.40	.0040	.0046	.0000	.0001	.03	.00	.....	..

Ice from Long Pond, Field of Robert Crowley, Concord, N. H.

Number.	Date of collection.	Appearance.				Residue on Evapo'n		Ammonia		Nitrogen as		Chlorine.	Hardness.	Lead.	Quality.
		Turbidity.	Sediment.	Odor.	Color.	Total.	Fixed.	Free.	Albuminoid.	Nitrates.	Nitrites.				
407	1902. Feb. 15	None	None	None	0.0	1.50	0.40	.0006	.0010	.0000	.0000	.02	.00	.....	..

SPECIAL INQUIRIES CONCERNING WATER SUPPLIES.

Special inquiries are constantly received at the office of the State Board of Health and at the Laboratory of Hygiene from individuals relative to their water supplies. These questions cover a great variety of conditions, and ask for advice as to how certain difficulties may be solved. One of the most common, perhaps, is from individuals who have sent specimens of well water to the laboratory for analysis, the result of which showed the water to be extensively contaminated by sewage from the adjacent privy, sink drain, barnyard, etc., and it is asked, "What can be done to make the water all right? Will cleaning the well solve the problem?"

Another question that is often presented, especially by owners of springs, is, "What kind of pipe shall be used, either in reaching a new supply or as a substitute for lead pipe already in use?"

Questions of varying character are frequently being presented to the board, and in all cases information and advice are given. The following correspondence is offered as an example, as well as for general instruction:

NORTHWOOD, N. H., December 21, 1901.

Irving A. Watson, M. D., Director Laboratory of Hygiene:

DEAR SIR,—The result of the analysis of my well water is something of a surprise to me, as I supposed the supply was quite pure.

A change of supply means much expense to me, and a great inconvenience, besides much hard work.

I desire to ask you what the expense will be to me to have one of your honorable board come to this place and make an examination of the well and its surroundings, and if possible locate the cause of pollution.

Awaiting your reply, I am,

Yours very respectfully,

D. N. TILTON.

LABORATORY OF HYGIENE,

CONCORD, N. H., December 24, 1901.

D. N. Tilton, Northwood, N. H.:

DEAR SIR,—The analysis of your water showed no present pollution, but an abnormal condition, which is doubtless due to seepage from privy, sink drain, or barnyard.

This seepage may have been going on for years until the earth around the well has become saturated. There is no way of improving the quality of the water. The conditions are such that a personal examination would be of no value, since even if the cause of pollution were found and removed the quality of the water might not improve for years.

Do not infer from my report that I consider the water injurious. It might be used for a long time without causing any trouble whatever, but the fact remains that there are always present conditions that render the water suspicious.

We shall be pleased to render any further aid which may be of use to you.

Very respectfully,

H. E. BARNARD,

Chemist.

SALMON FALLS, N. H., December 24, 1901.

State Board of Health, Concord, N. H.:

GENTLEMEN,—In reply to yours of recent date, stating that the water from my well was polluted and not fit to drink, I beg to ask you what we shall do to improve it.

Would a thorough cleaning out of the well and the addition of an air tube be liable to change the quality of the water?

What causes the water to be polluted?

Very respectfully,

JOSEPH HILL.

LABORATORY OF HYGIENE,

CONCORD, N. H., December 25, 1901.

Mr. Joseph Hill, Salmon Falls:

DEAR SIR,—The analysis of the water from your well showed it to be grossly polluted by sewage, as shown by the very high chlorine, nitrate, nitrite, and albuminoid ammonia content. This pollution may be due to contamination by sink drain, privy, or cesspool; it is impossible to tell which. The ground around the well is saturated by sewage which is constantly leaching into the ground water which supplies the well. Even if the conditions which are responsible for the pollution were found and removed, the quality of the water would improve very slowly, if at all.

I can advise no remedy which will improve the water, unless an examination shows you that there is some direct connection between the well and the above-mentioned sources of pollution. If this is found to be the case, a thorough cleaning of the well and a removal of the cause may effect a radical change in the quality of the water.

I am of the opinion, however, that your best course is to close up the well and look to unpolluted sources for your water.

We shall be very glad to be of further service to you in your search for pure water.

Very respectfully,

H. E. BARNARD,

Chemist.

LITERARY INSTITUTION, NEW HAMPTON, N. H., March 14, 1902.

Mr. H. E. Barnard, Chemist, Concord, N. H.:

MY DEAR SIR,—Your careful statement of water analysis is at hand. I am very thankful to you for your evidently painstaking quantitative work. I regret, however, to find that our water, which is otherwise so potable, has been found to contain lead in a considerable quantity. It would be a matter of quite large expense to replace the lead pipe with some safer one, and I would be glad to receive a further word from you before considering a plan for so doing. First, the water has been used by an earlier holder of the place for many years without injury. This is, of course, of no consequence in the present case.

Now, further, the supply of water is sufficient to furnish a much more rapid flow, all the year, than we have permitted. Would not a more rapid flow for the shorter distance largely reduce the apparent danger? Is not the amount of lead almost a minimum for water so carried? What pipe would you advise? Iron pipe rusts away here, and cannot be used.

I am sorry to trouble you further, but am much disappointed and am in hopes a change of pipe may not be absolutely necessary.

I am, sir,

Yours very respectfully,

HENRY W. BROWN.

LABORATORY OF HYGIENE,

CONCORD, N. H., March 21, 1902.

Prof. H. W. Brown, New Hampton:

DEAR SIR,—Yours of the 14th inst. has remained unanswered because of a press of work. I trust this late reply will be satisfactory.

While the amount of lead present in your water appears to be very small, the fact that the system generally refuses to throw it off makes even these slight quantities harmful and under the proper conditions might cause lead poisoning.

Unless the water dissolves lead very rapidly, there should be but traces present in constantly running water, and if, as you say, a much more rapid flow can be obtained, your supply will probably be quite free under the new conditions.

If you are contemplating putting in new pipe, I advise the use of cement-lined iron pipe if it can be obtained. There is a tarred iron pipe which also gives excellent satisfaction after the taste and odor of the tar have disappeared. The one other pipe to be considered is the ordinary galvanized iron pipe, which is so generally used. There is no danger from zinc poisoning in its use, but in some soils it lasts but a few years.

It remains for the pipe manufacturers to bring out a pipe which is safe and durable, but at present the only approach to that end is the above-mentioned cement-lined pipe.

Very respectfully,

H. E. BARNARD,

Chemist.

SOMERSWORTH WATER-WORKS, COMMISSIONERS' OFFICE,

SOMERSWORTH, N. H., April 30, 1902.

Mr. H. E. Barnard, Chemist, Concord, N. H.:

DEAR SIR,—I take pleasure in writing you for information in regard to securing analyses of our city water. We are paying five dollars each time we have the water analyzed, and as it is examined each month the cost in a year is considerable.

I write to you to inquire what it will cost to have the water analyzed at your laboratory at least once a month.

Yours respectfully,

P. D. O'CONNELL,

Superintendent Water-Works, Somersworth, N. H.

LABORATORY OF HYGIENE,

CONCORD, N. H., May 2, 1902.

P. D. O'Connell, Superintendent Water-Works, Somersworth, N. H.:

DEAR SIR,—In answer to your letter of the 30th inst., it gives me great pleasure to assure you of our willingness to examine your city water once each month without expense to you, except the express charges on the samples.

The laboratory was established for the use of the people of the state, and we desire to make examinations of all the water supplies as rapidly and frequently as we can.

We furnish our own collecting bottles, which are sent upon request, together with full directions for sampling and shipping.

Unless you think otherwise, it seems advisable to make the examination of your supply about the first of each month and, therefore, without word from you, I shall hereafter ship you a bottle for collecting the sample at that time.

Please give me very full instructions and information concerning this first sample, for which I am shipping you a bottle today, that I may understand how complete an examination you desire and, as well, the location and surroundings of your supply.

I prefer not to have samples shipped so late in the week that they will reach me on Saturday, as that makes it necessary for the analysis to be made on Sunday, at considerable inconvenience to me.

Again assuring you of our desire to serve you and to aid you in securing for the people of Somersworth a pure and wholesome water supply, I am,

Very respectfully yours,

H. E. BARNARD,

Chemist.

In a communication received from James Ayer, secretary of the board of Health of Salem Depot, he outlines the plan of supplying the town with water from Canobie lake, and makes inquiry concerning the kind of supply pipe most suitable for use with water like sample No. 228.

The reply from the Laboratory is as follows:

LABORATORY OF HYGIENE,

CONCORD, N. H., July 28, 1902.

James Ayer, Secretary Board of Health, Salem Depot, N. H.:

DEAR SIR,—In reply to your communication of July 28, 1902, concerning the kind of pipe most suitable for use with water like sample No. 228, I will advise you as follows:

It is never safe to employ lead pipe as a carrier for water when the water is soft or contains organic matter, or when the solid or mineral matters are low. The water from Canobie lake is very soft; the solid contents are exceptionally low; and the organic matter present is high.

It would undoubtedly be unwise to use lead pipe in conveying this water. The use of galvanized iron pipe* with water of this character is not to be

*What might appear to the uninformed to be a discrepancy between the statement made in Mr. Barnard's letter to Prof. Brown on the subject of galvanized iron pipe, and that expressed in this letter is readily explained from this point of view. In all new galvanized iron pipe for a short time after it is put in, the water has a foamy, frothy appearance, and is charged with fine particles of zinc from the inside surface of the pipe. This, in a short system with single pipe, like that contemplated by Prof. Brown, is rapidly removed, and the danger, if there is any, eliminated. In this case a proposed public water supply is under consideration, and with its long mains and extensive ramifications of smaller pipe there might possibly be some danger of zinc poisoning, in especially susceptible persons, from the relatively large quantity that would be delivered from the pipes, which condition would not be found in a short line that can be readily washed out.

I. A. W.

advised, as there is some danger of zinc poisoning from the traces of zinc dissolved by the water. Plain iron pipe is perfectly safe. The only objection to its use is its liability to rust.

In the city of Concord, where the quality of the water is very similar to that of Canobie lake, a cement-lined pipe is employed in making connections with the mains. This is, in my opinion, the most durable and most desirable pipe made that is not too expensive for general use. The cement-lined pipe is not offered for sale, as it cannot be shipped because of its liability to breakage in transit.

Machines for lining ordinary iron pipe with cement are for sale, however, and the pipe is easily and cheaply prepared at the place where it is to be laid. Tarred iron pipe can be procured which will prove durable and inexpensive. The taste and odor of the water conveyed through tarred pipe are not pleasant when the pipe is first laid, and might prejudice some against using the water.

If lead or galvanized iron pipes are used, the quality of the water will be affected; if other kinds of pipe are laid the water will not be affected and the pipe but slightly, if at all.

Trusting that I have answered your questions satisfactorily, and assuring you of our appreciation of the way you are looking after the water supplies of your town, I am,

Yours very respectfully,

H. E. BARNARD,

Chemist.

SOME DATA CONCERNING THE PROPOSED CHLORINE MAP OF NEW HAMPSHIRE.

In the course of a water analysis there are two points to be considered which are essential in revealing the true character of the water,—the quantity of nitrogen present in its various forms, and the amount of chlorine. The nitrogen may exist as free and as albuminoid ammonia, which is subject to oxidation to nitrites and nitrates, thus changing it from organic life to inorganic matter, as salts of soda, lime, and potash. But the chlorine content is constant. The stability of its salts fixes its presence, and once a constituent of a water supply it never disappears.

The chlorine present in water is almost always due to the presence of common salt, chloride of sodium, of which 60 per cent is chlorine, and the sources of chlorine are usually the sink drain, with its burden of salted water from domestic operations, the house drain with its chlorine containing excreta, and the stable drain with a slight chlorine content in comparison with the other two. Chlorine may also be derived from the commercial fertilizers so commonly used in farming operations. But chlorine is of itself not harmful. Its use to the chemist is due to the fact that its presence reveals a past or present history of pollution by some form of sewage, and where sewage is the typhoid germ may be.

*There are no data in this country sufficiently complete from which we can determine the amount of chlorine contributed to sewage by each inhabitant per day. Calculations based on observations in England indicate that the amount is approximately .045 pound per day per person; and, broadly speaking, we may say that four families, or twenty persons per square mile, will add, on an average, .01 of a part per 100,000 of chlorine to the water flowing from this area, and that a very much smaller population will have the same effect during seasons of low flow.

It is well known that the best waters contain traces of chlorine due to the fact that the winds blowing from off the ocean bear inland salt-laden moisture, which is precipitated as rain. The amount present in a given locality is fairly constant, but is somewhat influenced by the direction and force of the winds, and the amount and distribution of the rainfall. However, a series of analyses of waters of known purity will establish a chlorine content which is, for all ordinary purposes, a constant. This is called the normal chlorine. Whenever sewage finds access to water the amount of chlorine present exceeds the normal according to the percentage of sewage in the supply.

It is therefore of great importance to the water analyst that the normal chlorine for each water examined is known. With this knowledge at

*Report of State Board of Health of Massachusetts for 1890, page 680.

hand it is possible to determine whether chlorine present in a supply is due to the influence of the sea or to sewage. For example, a water at Hampton may contain, under perfectly normal conditions, .6 parts of chlorine per 100,000, while an equally pure supply at Hanover contains but .07 parts per 100,000. The chlorine content of the Hanover water may be increased nine times before it reaches the percentage of the Hampton supply,—that is, a large amount of sewage may be introduced before its presence is manifested in the chlorine content unless the normal chlorine content for Hanover is known.

We are making extensive investigations in order to determine the normal chlorine for each town in the state. Through the boards of health we are collecting samples of surface waters and springs of known purity whose drainage areas are uninhabited and in no way liable to pollution. We collect three samples from each town, so that the results obtained may not be influenced by any unknown local conditions, and the analyses will be repeated at suitable intervals until absolute values are determined. It is also possible to make use of many of the regular water analyses where there is no evidence of pollution.

During the past year we have determined the chlorine content of upward of 250 uncontaminated supplies, and from the results obtained have deduced the approximate normal chlorine content of the waters of sixty-seven towns. These figures are subject to revision as the various supplies are re-examined, but the variation from the first results is slight in most instances.

Near the coast normal chlorine content changes very rapidly. In the town of North Hampton, water half a mile from the coast contains upward of 2 parts of chlorine per 100,000. One and a half miles from the coast the chlorine content has dropped to 1 part per 100,000, while five miles from salt water the figure is .8 parts.

The normal chlorine of Stratham is .64 parts per 100,000, and that for the adjoining town of Newmarket is but .35 of a part, a drop of .3 parts in a few miles. The variations throughout Cheshire, Sullivan, and Grafton counties do not amount to more than .05. Waters north of the White Mountains do not show any evidence of being influenced by the storms which occasionally sweep inland from the Atlantic, and their chlorine content is as low as can safely be determined.

It is interesting to note that the great bay which flows inland from Portsmouth for twenty or more miles does not greatly change the chlorine content of adjacent waters, although deep well waters near Great bay and Exeter river frequently show increased chlorine. This is due to the mingling of the brackish waters of the river with the natural ground water supply. In the examination of supplies from Exeter excessively high

chlorine contents have been observed, which could not have been due to any other cause.

The work of making an accurate chlorine map involves prolonged study of the natural water supplies of the state, but it is a matter of such great importance that it will be hastened as rapidly as possible. We are greatly indebted for the willing co-operation of the various boards of health who have aided us in collecting samples and in furnishing the necessary data, and we trust that every person who assists us will do so conscientiously and willingly, fully understanding the part he is taking in making the chlorine map of New Hampshire.

EXAMINATION OF MILK.

EXAMINATION OF MILK.

Owing to the great amount of water work constantly on hand, we have not attempted to make any systematic inspection of milk, and have confined our work in that direction to making corroborative analyses when called upon to do so by the milk inspectors of towns and cities. With few exceptions the milk supplies of the state do not receive the care and attention they require. But few of the cities and towns have appointed milk inspectors, as they are authorized to do, and consequently there is no way of regulating the quality of the milk sold. This neglect allows the unscrupulous dealer to practice systematic fraud upon his customers. Watered or skimmed milk, weakened and robbed of its fat and valuable qualities, is sold to furnish food to sick and nursing children; preservatives are largely used to keep milk spoiled by dirty and careless handling; coloring matters are employed to give the rich appearance of cream to the milk. With agents or milk inspectors in the cities and towns working in co-operation with the Laboratory of Hygiene, it would be possible to raise materially the standard of milk sold.

The city of Manchester, after years of lax inspection, has given the board of health control of the inspection of milk, and the results achieved under the new management have been remarkable. The small dealers, retailers of two or three cans of milk a day, with no proper facilities for handling milk, have been driven out of the business, and a complete registration of milkmen is kept and their stables inspected. A full account of their methods and the results reached is included in this report.

The State Laboratory of Hygiene has assisted their inspector in several court cases. All suspicious samples of milk, either poor in quality or treated with some preservative, are sent, under seal, to the laboratory, where a careful examination of the milk is made. If the results confirm those reached by the milk inspector action is at once brought against the dealer who sold the milk.

Following is the summary of results obtained during the past year:

Analyses of Milk.

No. of sample.	COLLECTED BY	Date.	Total solids.	Solids not fat.	Fat.	Preservative.	Disposal of case.
		1901.					
1A	Board of Health, Manchester.	Aug. 23	13.20	8.86	4.34	Formaldehyde.	Sentence imposed by Superior Court.
2 A No. 51	Board of Health, Manchester.	Aug. 29	.....	.....	.....	No formaldehyde.	.....
3 A No. 52	Board of Health, Manchester.	Aug. 29	.....	.....	.....	No formaldehyde.	.....
4 A	Geo. A. Berry, Insp., Concord.	Sept. 7	.....	.....	2.50	.....	.....
5 A No. 105	Board of Health, Manchester.	Sept. 9	.....	.....	.....	No preservative.	.....
6 A	A. K. Day, M. D., Concord.	Sept. 11	12.95	9.55	3.40	.....	.....
7 A No. 110	Board of Health, Manchester.	Sept. 11	9.60	7.175	2.425	No color used.	.....
8 A No. 128	Board of Health, Manchester.	Sept. 20	10.68	8.78	1.90	.....	.....
9 A No. 157	Board of Health, Manchester.	Sept. 25	11.08	8.43	2.65	No preservative.	.....
10 A No. 158	Board of Health, Manchester.	Sept. 25	.....	.....	.....	Formaldehyde.	.....
11 A No. 159	Board of Health, Manchester.	Sept. 25	.....	.....	.....	No formaldehyde.	.....
12 A No. 162	Board of Health, Manchester.	Sept. 25	.....	.....	.....	Formaldehyde	Sentence imposed by Superior Court.
13 A No. 164	Board of Health, Manchester.	Sept. 26	.....	.....	.....	Formaldehyde.	.....
14 A No. 165	Board of Health, Manchester.	Sept. 26	.....	.....	.....	Formaldehyde.	Sentence imposed by Superior Court.
15 A No. 18	Geo. A. Berry, Insp., Concord.	Dec. 11	13.28	.....	.....	.....	.....
16 A No. 19	Geo. A. Berry, Insp., Concord.	Dec. 11	11.22	.....	.....	.....	.....
17 A No. 26	Geo. A. Berry, Insp., Concord.	Dec. 12	11.37	.....	.....	.....	.....
18 A No. 27	Geo. A. Berry, Insp., Concord.	Dec. 12	12.21	.....	.....	.....	.....
19 A No. 30	Geo. A. Berry, Insp., Concord.	Dec. 13	11.40	.....	.....	.....	.....
		1902.					
20 A No. 718	Board of Health, Manchester.	Feb. 20	9.34	6.59	2.75	No preservative.	.....
21 A No. 719	Board of Health, Manchester.	Feb. 20	11.00	7.70	3.30	No preservative.	.....
22 A	C. H. Noyes, Nashua.	Mar. 24	17.41	.....	.....	.....	.....
23 A No. 786	Board of Health, Manchester.	Mar. 29	.....	.....	.....	Formaldehyde.	Sentence imposed by Superior Court.
25 A	F. W. Barnes, Milford.	Apr. 1	12.89	8.99	3.90	.....	.....
26 A No. 920	Board of Health, Manchester.	May 3	.....	.....	.....	No preservative.	.....
27 A No. 1019	Board of Health, Manchester.	May 19	.....	.....	.....	No formaldehyde.	.....
28 A No. 1174	Board of Health, Manchester.	June 26	.....	.....	.....	Formaldehyde.	Indicted by grand jury. Case still pending.
28			12.045	8.26	3.02		

Formaldehyde was found to be present in seven cases.

Mr. H. E. Barnard, State Chemist, Concord, N. H.:

At your suggestion I submit the following report upon the inspection of milk in the city of Manchester, for the year beginning September 1, 1901.

The inspection of milk had been under the direction of the board of health for about two months at this time and was in good running order. A labor-

atory had been fitted up in the office and apparatus for making milk tests and analyses had been procured. The record books of the previous milk inspectors had been turned over to us, and all dealers in milk, skim-milk, and cream (including stores) who were not already licensed were compelled to obtain one.

A great many were found who had not paid the license fee for several years, and when called upon by the inspectors to produce their license displayed one long since expired. Many people who keep but one cow and have only a few customers complain because they are obliged to pay as large a fee as those who sell hundreds of quarts a day. Several persons were made to pay who had bought out some licensed dealer, and who had taken it for granted that they had purchased the license also. The board was obliged to use strenuous language in the newspapers and in other ways to make some of the dealers comply with the law.

Two hundred nineteen licenses have been granted by this board since June 1, 1902, and we feel sure that no milk is sold in the city at the present time by any but licensed dealers. This part of the work is done by the office clerk, and many dealers have expressed their gratification at being able to come to an office where, during certain hours, they are sure to find some one with whom they can transact their business.

From the beginning we have made it a rule that no figures found in the analysis of milk should be given out. If a sample of milk is found to be below the legal standard the dealer is notified of the fact, but if it proves to be all right he understands that no report is necessary. We have made it a practice to test all samples of milk which are left at the office, either by citizens, milk dealers, or milk raisers. This has been a great help to the milk dealers in keeping up the quality of their milk, and the result has been that some of the raisers have disposed of their poor cows.

When a dealer or raiser leaves milk to be tested we make out the report and designate the quality of the milk by such terms as, excellent milk, good milk, fair, and below standard in butter fats, or below standard in solids. We believe this has saved us a great deal of fault-finding, and is just as good for the milk trade as figures, which are not generally understood.

One thousand four hundred fifty-three samples of milk, skim-milk, and cream were collected and tested during the year beginning September 1, 1901. Fifty-three samples were found below the standard in butter fats and total solids.

One hundred eight samples of milk, taken in September, 1901, averaged 4.04 per cent of butter fat, and 12.29 per cent total solids. Six samples were below the legal standard in butter fat and total solids.

Six hundred thirty-six samples of milk collected in October, November, and December, 1901, and January, February, and March, 1902, averaged 4.11 per cent of butter fat and 12.83 per cent total solids. Thirty-four samples were below the legal standard in butter fat and total solids.

Six hundred fifty-six samples of milk taken in April, May, June, July, and August, 1902, tested an average of 3.87 per cent of butter fat, and 12.34 per cent total solids. Thirteen samples were below the legal standard in butter fat and total solids.

Twenty-three samples of cream were collected and analyzed, the average per cent of butter fat being 29.25. Several samples were tested for the vol-

atile acid fats by the Reichert-Wollny method and a high number was obtained. The specific gravity of the butter fat was also ascertained. Nineteen samples of skim-milk tested an average of .48 per cent butter fat and a specific gravity of 1.0334. Some of the skim-milk samples I tested for the specific gravity of the milk serum.

Several samples of milk were tested for butter fat by the Adams method, and the results corresponded very closely with the Babcock method. The total solids given were estimated by means of the specific gravity of the milk and the amount of butter fat. Seventeen samples were dried out to get the total solids, and they generally corresponded very closely with the estimated results. Nearly all of the samples of milk which were found to be below the standard for butter fat and solids, I tested for the specific gravity of the milk serum, and in several instances found milk which was undoubtedly watered. These I followed up by having the dealers obtain samples from each cow, and proved this to be the case. Such dealers were warned that they were responsible for this milk even if they did not raise it.

About the middle of May, 1902, I began to make tests for the acidity in the milk, using the Mann volumetric method of analysis. This was done for several reasons, chiefly to give us some idea of the condition of the milk which was being delivered to the public, and also to detect preservatives in the milk, as a high percentage of acidity, without any sour taste or smell, would indicate that some boric acid or similar preservative was used, and a low percentage of acidity would give us reason to believe that sodium was present.

Four hundred forty-three samples of milk were tested for acidity, with an average of .168 per cent. This we consider to be an excellent showing, and it speaks well for the raisers and dealers in milk in this vicinity, showing that great care is exercised in cleaning the cans and utensils used in putting up the milk.

The first prosecution for violation of the law occurred in August, 1901, a sample of milk numbered 16 being purchased by Inspector J. F. Looney on August 11. This sample was tested by W. K. Robbins, of the local board, and by the state chemist, Mr. H. E. Barnard, and was found to contain formaldehyde, used as a preservative.

This case was placed in the hands of Chief of Police M. J. Healy, and the dealer was summoned before the police court, waived examination, and was bound over to the September term of the superior court. The grand jury returned an indictment and sentence was imposed.

Four other dealers have been prosecuted during the year, with similar results, and one case is still pending.

The progress made during this first year of milk inspection has been very satisfactory, and the success has been due in a great measure to the assistance of Mr. W. K. Robbins of this board, a chemist by profession, who has given valuable instruction in the laboratory work.

Respectfully submitted.

C. O. SEAMAN,

Milk Inspector.

OFFICE OF INSPECTOR OF MILK, CITY HALL,

NASHUA, N. H., March 24, 1902.

Mr. H. E. Barnard:

DEAR SIR,—In the accompanying box is a sample of milk taken from a herd of cows Saturday morning, then cooled and sold in the city the same day. As you will see, it is ropy and decidedly abnormal. This dealer has had similar trouble with his milk for about a week, perhaps fifty of his customers complaining about it today.

Another dealer living ten miles from the first has also had trouble. Very likely there are others that I have not found out.

Now have you at hand the means of finding out the cause of the trouble? And can you suggest remedies? I take it that the change is produced by organisms which cause a fermentation. Am I correct in this?

The dealer who has had the most trouble is a clean, careful young man. Any suggestion on this matter will be gratefully received.

Yours truly,

CHARLES H. NOYES.

LABORATORY OF HYGIENE,

CONCORD, N. H., March 25, 1902.

Prof. C. H. Noyes, Nashua, N. H.:

DEAR SIR,—Your sample of milk with inclosed note received.

Stringy milk may be produced by the rapid growth of a certain bacillus, especially in hot, moist weather, or may be due to the systematic condition of the cow. I believe veterinarians claim it is due to a specific disease, and in your cases the cows should be treated or inspected by some competent person, who will recognize the trouble and will be able to cope with it.

An examination of the milk gives a total solid content of 17.41 per cent, which is far above the normal, and an examination under the microscope shows several classes of bacteria to be present in great numbers. The trouble in this case is not due to uncleanliness, but to the condition of the cows, and while the milk continues thick and stringy it should not be used.

Ordinarily the duration of the disease is short, but in some cases the cows do not recover. I can only advise inspection of the herds by a veterinarian, as the best and safest course to pursue.

Very respectfully,

H. E. BARNARD,

Chemist.

NOTES ON THE DETECTION OF FORMALDEHYDE IN MILK.

Of all the foods and drinks of man there is perhaps none which is more important than perfectly pure, clean, and healthful milk, and to secure it should be the subject of earnest care.

It is well known that milk undergoes a number of chemical changes in its constitution some hours after milking. It becomes sour, owing to the decomposition of the milk sugar, the casein separates, and finally putrefactive decomposition begins. These changes are evidenced by the presence in milk of bacteria, which, for the most part, do not generate diseases, but which may be and often are accompanied by harmful bacteria that obtain access to the milk from the body of the animal, from the air, from the water used in washing the cans, from the hands, clothing, and person of the milker, and the like. Even when collected with precaution, the careless distribution of milk from cart or store may result in its contamination with disease-producing bacteria.

The importance of a method, or methods, of protecting milk from these minute forms of life, which may cause so much damage, or of rendering them harmless, is evident. Several methods have been adopted to secure this end. The most important are pasteurization and sterilization. The simple pasteurization of milk is useful, provided the milk is immediately cooled, and used within twenty-four hours. But careful sterilization is the most effective method of preserving milk. Thorough cleanliness in the stable and dairy, the use of sterilized instruments for the collection of the milk, and careful and scientific handling of the product at every step between the cow and the consumer will be most effective in preventing the entrance of bacteria and consequnt souring of the milk.

A third method of preserving milk is by the use of chemicals which either neutralize the acidity of the milk or retard the growth of bacteria. However, preservation by chemical means is neither satisfactory nor advisable. The agents employed are injurious to health even in small quantities, if taken continuously.

The temptation to the unscrupulous dairyman or milk vender to cover his lack of cleanliness and proper subsequent care by the use of chemical preservatives is great. Many preparations have been advocated for this purpose, including bicarbonate of soda, and boric and salicylic acid. Within the last decade an aldehyde, known as formic aldehyde, methanal, methyl aldehyde, formaldehyde, etc., of the formula (H C H O), of valuable germicidal and antiseptic powers, has been brought into prominence and largely employed in the preservation of milk and other foods.

For ordinary uses formaldehyde appears on the market as an aqueous solution from 33 to 40 per cent strength, under the trade name of

Formalin. As a milk preservative it is also sold under various misleading names, as Freesine, Preservaline, Formol, Freezaline, Anti-Sour, etc. These preparations are sold in weak solutions, in some instances not containing more than 2½ per cent formaldehyde, and are accompanied by the most engaging claims for usefulness.

There are unquestionably many milk dealers who are honest and who serve honest milk and who are so cleanly in their methods of handling their product that they do not have to rely upon the aid of formaldehyde or other preservatives. On the other hand, it is sadly true that in many communities there are dealers who, through ignorance or unscrupulousness, do add foreign and deleterious substances to their milk. It is well that such conditions are met by legislation, and that the selling of milk containing preservatives is a violation of the laws of the state. But since the adulteration exists and the only remedy is prosecution, there must be methods for the detection of the adulterants. Fortunately the detection of formaldehyde in milk is comparatively easy for one who has had some laboratory experience.

Quite a number of methods for the detection of formaldehyde in milk are in use, and while it is not our object to review all of them, it may be helpful if we give briefly some of the simple tests:

1. Hehner's Test.

This method depends upon the fact that when milk containing formaldehyde is mixed with sulphuric acid containing a trace of ferric salt a blue color appears.

Place 5 cc. milk in a test tube and dilute with an equal volume of water. Carefully pour down the sides of the test tube strong sulphuric acid containing a trace of ferric chlorid, so as to form a layer of acid below the milk. If formaldehyde is present a violet ring is formed at the junction of the two liquids. One part in 100,000 may be detected.

Caution. The acid used should be of 1.81-1.83 specific gravity, and must contain a trace of ferric salt.

The charring due to the action of the acid on the milk must not be mistaken for the color reaction.

2. Hydrochloric Acid Test.

Hydrochloric acid containing a small amount of ferric chlorid gives a characteristic violet with quantities of formaldehyde not over one part to 1,000.

The test is applied by heating 1 cc. of the sample in a test tube with 4 cc. of strong hydrochloric acid containing a trace of ferric chlorid. A purple color appears, varying from a delicate tint to a deep violet, if formaldehyde is present.

Caution. If a yellow color appears, repeat the test, using milk that has been diluted, 1 to 10, with water.

3. Lebbin's Test.

Boil a few cc. of the sample with .05 grams resorcinol, to which half, or an equal volume, of a 50 per cent solution of sodium hydroxide is added. If formaldehyde is present, the yellow solution changes to a fine red color. This color becomes more apparent on standing.

4. The Denige Test.

This test depends on the reaction of Schiff's reagent with formaldehyde. The following solution must be prepared:

40 cc. of ½ per cent solution of fuchsine.

250 cc. distilled water.

10 cc. of sodium bi-sulfite of 1.375 specific gravity.

10 cc. pure sulphuric acid.

Add 1 cc. of the above solution to 10 cc. of the suspected milk and let it stand for five minutes. Then add 2 cc. of pure hydrochloric acid and shake. A violet color will appear in the presence of formaldehyde; a yellowish white color in its absence.

5. Jorissen's Test.

Several drops of a 10 per cent aqueous solution of phloroglucinol are added to 10 cc. of the suspected milk in a test tube, well shaken, and a few drops of caustic potash (or caustic soda) added. If formaldehyde is present a delicate red color appears.

This test is very easily applied and gives excellent results. One part of formaldehyde in 100,000 can be detected.

In some cases formaldehyde may be detected by its characteristic odor when the milk is warmed. Hehner has observed that formaldehyde disappears from milk on standing. He found that one part in 100,000 could not be detected after one week; one part in 50,000 after two weeks; and one part in 25,000 after three weeks.

There may be errors in special cases by any one given method, and it is advisable, when a positive reaction is obtained, to confirm it by employing at least one other method, and preferably more.

STATE LABORATORY OF HYGIENE.

STATE LABORATORY OF HYGIENE.

In 1899 a bill was before the legislature for the establishment of a laboratory of hygiene, to be under the management of the State Board of Health. This measure was favorably reported upon by the committee on public health, and subsequently referred to the committee on appropriations. After a hearing on the subject the committee reported that, while they believed that a laboratory of hygiene would be of public benefit, owing to the amount of money already appropriated for other purposes they deemed it best to refer the matter to the next legislature, which was done.

In 1901 the matter was again taken up, favorably recommended by the committees on public health and appropriations, and became a law without any opposition to speak of.

The bill was as follows:

AN ACT TO ESTABLISH A LABORATORY OF HYGIENE.

Be it Enacted by the Senate and House of Representatives in General Court Convened:

SECTION 1. The State Board of Health is authorized to establish and equip a laboratory with the proper and necessary apparatus, utensils, and instruments for the chemical and bacteriological examination of water supplies, milk, food products, drugs, etc., and the investigation of cases and suspected cases of diphtheria, typhoid fever, tuberculosis, pneumonia, malaria, glanders, and other infectious and contagious diseases.

SECT. 2. The said board shall employ a chemist, and shall, as far as practicable, make investigations and analyses of public water supplies, and of foods and drinks offered for sale in our markets, and shall conduct investigations along these lines, with a view to discovering adulterated and fraudulent products, and shall enforce the law relative to the same, as provided for in chapter 269 of the Public Statutes.

SECT. 3. The board shall also provide for the bacteriological examination of cases and suspected cases of diphtheria, typhoid fever, tuberculosis, glanders, and such other diseases as it may deem necessary, including any diseased condition that may be found in slaughtered animals, and in cases of infectious diseases shall report its findings immediately, by telegraph or telephone, to the physician requesting the same.

SECT. 4. The State Board of Health may publish quarterly in a bulletin the results of the analytical work done in said laboratory, naming fraudulent and adulterated articles of food found on sale in this state, together

with such other information relating to sanitary matters as it may deem advisable, and the said board shall conduct its investigations along such lines as it may deem to be for the greatest public utility. It shall make special investigations into the character and quality of the water supplies of any locality in the state when requested by any board of water commissioners, board of health, or by consumers.

SECT. 5. All investigations conducted in the said laboratory shall be free to the people of this state.

SECT. 6. The sum of two thousand dollars is hereby appropriated for the purpose of procuring the proper and necessary apparatus, utensils, and instruments for the equipment of such laboratory, and the sum of five thousand dollars, or as much thereof as may be needed, is hereby appropriated for each of the years 1901 and 1902 to pay the necessary expenses of said laboratory, the purchase of supplies, and such other incidentals as may be required, which sums shall be expended under the supervision and direction of the State Board of Health, and all expenditures shall be audited by the governor and council.

SECT. 7. This act shall take effect upon its passage.

[Approved February 20, 1901.]

A few months after the passage of this bill, suitable rooms had been secured in a block in the city of Concord, and duly equipped as far as possible under the appropriation made for that specific purpose, and work was commenced in May, 1901.

The secretary of the State Board of Health was made director of the laboratory, Mr. H. E. Barnard was appointed chemist, and Drs. Howard N. Kingsford of Hanover and Arthur K. Day of Concord, bacteriologists.

It was thought best to establish two bacteriological departments in different sections of the state, for the convenience of physicians in obtaining immediate reports upon specimens sent, particularly in diphtheria cases, and therefore the board established two laboratories,—one at Hanover, in charge of Dr. Kingsford, and the other at Concord, in charge of Dr. Day. The physicians of the state were instructed that specimens for bacteriological examinations might be sent to either place, as was most convenient. It was decided that all work in chemical analysis should be done at the Concord laboratory.

CHEMICAL DEPARTMENT.

This department, as noted above, was placed in charge of Mr. H. E. Barnard, B. S., a native of New Hampshire and a chemist of repute, who resigned a government position which required the most accurate analytical work to accept the position tendered.

The laboratory was fairly well equipped with apparatus for the most needed lines of work, particularly for the analysis of water. While the greatest amount of work has been done in the examination of water sup-

plies, considerable has also been accomplished in other directions. The analysis of public and private water supplies has been carried on to an extent that has accomplished most excellent results. The work of Mr. Barnard has been shown very fully in the articles on "Examination of Water Supplies," "Water Supplies of Cities and Towns," "Lead Poisoning," etc., as will be seen by an examination of most of the preceding matter in this report. One need only to study that part of the report to be convinced of the importance of the work done in the chemical department of the laboratory during its first year of existence.

BACTERIOLOGICAL DEPARTMENT.

Work in this department is practically limited to bacteriological examinations for the investigation of suspected cases of tuberculosis, diphtheria, typhoid fever, glanders, etc., and for the determination of micro-organisms in drinking water, milk, cream, butter, etc., and for diseased conditions found in slaughtered animals. It is not intended at present to undertake the examination of pathological products outside of those mentioned. Blood counts, urinary analyses, the examination of stomach and other organs in cases of suspected criminal poisoning, cannot be undertaken at the laboratory under present conditions. Matters pertaining more directly to public health questions, as well as the fact that our equipment is not sufficient for the latter-named work, preclude examinations of this kind. In the following pages will be given briefly an account of work done in the bacteriological department.

TUBERCULOSIS—EXAMINATION OF SPUTA.

It is of vital importance for the successful treatment of tuberculosis that the disease be positively recognized and determined in its earliest stages. It has been demonstrated beyond all reasonable controversy, that a very large proportion of cases of tuberculosis might be cured were they discovered in their incipiency and proper treatment given. Not infrequently is it impossible to diagnose a suspected case until the bacillus of the disease has been discovered, or excluded by repeated bacteriological examinations.

OUTFITS.—For the purpose of making the laboratory as available to the physicians of the state as possible, outfits for the collection of samples of sputum were placed in one or more drugstores in all the cities and most of the towns of the state. In some instances, where there were no drugstores, outfits were sent direct to the local physician, the object being to place these outfits so that they would be readily accessible at any time.

The outfit first sent out for the collection of sputum consisted of a small glass jar, encased in a wooden shipping tube, already labelled for shipment to the laboratory. Later, it was thought advisable to test the practical utility of the wooden (Hart's) sputum box, which was coated on the inside with asphaltum paint, so as to make it impervious, and inclosed in a pasteboard shipping box, with printed address, so that the whole combination might be of the greatest possible convenience in practical use. We have found these boxes to be unsatisfactory, for the reason that they crack so that there are numerous little fissures, allowing the sputum to pass through the bottom or top of the box. Even with subsequent recoating some difficulties of the same kind were met with. It is believed that most of the boxes distributed throughout the state, by reason of having been recoated (some of them two or three times) at the laboratory, are all right for the intended purpose. Their use, however, will be discontinued after the exhaustion of the present lot, and the little glass sputum jar first sent out again used.

Each outfit is accompanied with a blank for the purpose of obtaining as much data as possible relating to the cases. The following is a copy:

TUBERCULOSIS.

SPECIMEN FOR EXAMINATION.

Doctor's name.....
City or town.....
Patient's name.....
Age.....**Sex**.....

Occupation .....
Number of specimen: 1st, 2d, 3d.....
Sputum—When was specimen discharged?.....
Duration of disease.....
Are there any other cases in same household?.....
If so, how many?.....
Clinical diagnosis.....

RETURN THIS BLANK, FILLED OUT, WITH THE SPECIMEN.

All charges for transmission must be paid by the party sending the specimen; and also telegraph or telephone charges in reporting results. Report will be sent by mail, as soon as possible, unless otherwise ordered.

Send Specimen to Concord or Hanover, as may be most convenient.

Received .....
Incubator .....
Result .....
Reported .....
Mail, Telephone, Telegraph.

Upon the reverse side of the above blank is the following:

Remarks:

.....
.....
.....
.....
.....
.....
.....
.....

NEW HAMPSHIRE STATE BOARD OF HEALTH.

LABORATORY OF HYGIENE.

DIRECTIONS FOR COLLECTING AND SENDING SPUTUM.

The expectoration discharged in the morning is preferred.

Have the patient wash out the mouth and throat with pure water early in the morning, and then cough up the sputum from the lower air passages.

Care should be taken that the contents of the stomach, articles of food, etc., are not discharged during the act of expectoration and collected instead of ordinary sputum. Purulent, cheesy, and muco-purulent sputum most frequently contain the bacilli; pure mucous, blood, or saliva do not as a rule contain the bacilli.

If the expectoration is scanty, the entire amount discharged in twenty-four hours should be collected.

The sputum should not be kept, but forwarded in as fresh a condition as possible.

Sputum must be sent in jars furnished for the purpose by the State Board of Health, and must not be sent by mail.

Arrangements have been made with the express companies to make a special delivery of specimens sent to the laboratory, so that there may be no delay in obtaining results. Sputum is examined, as a rule, on the following morning after its receipt, and the physician sending same notified of results on the following blank form:

Laboratory No.....

LABORATORY OF HYGIENE,

NEW HAMPSHIRE STATE BOARD OF HEALTH.

BACTERIOLOGICAL DEPARTMENT.

.....N. H.,.....190.....

DR.....

.....

DEAR SIR:

The examination of the sputum from.....
.....received on
.....shows does not show the presence of
.....tubercle bacilli.

The result is not reported as *negative* in any case until after a thorough examination of the specimen submitted. The *positive* results are expressed as *few, moderate number*, or *numerous* tubercle bacilli.

Few signifies that the bacilli are not present in every field, but only one or more are to be found in the entire preparation or preparations.

Moderate number signifies that the bacilli are present in every field, but that each field contains less than five.

Numerous signifies that the bacilli are present in every field, and that each field contains more than five bacilli.

If the result of the examination is negative it is not to be assumed that the case is not one of pulmonary tuberculosis, for frequently in this disease tubercle bacilli are at times absent from the sputum, and the disease can only be *probably* excluded if repeated examination of the sputum fail to show the presence of bacilli. If the first examination in a case is negative, other specimens should be sent for examination.

The demonstration of the presence of tubercle bacilli in the sputum proves conclusively the existence of tuberculosis, but the absence of tubercle bacilli or the failure to find them microscopically does not exclude the existence of the disease.

.....M. D.,
Bacteriologist.

IRVING A. WATSON, M. D.,
Director of Laboratory.

SPECIMENS OF SPUTUM EXAMINED.

Up to the first of October, 1902, 1,158 specimens had been examined in cases of suspected tuberculosis, with results which are given in detail in the following table:

CITY OR TOWN.	Number of cases examined.	Positive.	Negative.	Doubtful.	1 to 10.	10 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.	Age not stated.	Male.	Female.	Not stated.	Number of examinations.
Acworth	5	1	4	....	....	....	1	....	2	1	....	....	....	1	....	5	....	6
Allenstown	22	10	12	....	....	1	8	6	3	....	3	....	....	1	9	13	....	23
Amherst	1	1	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1	1
Andover	4	2	2	....	....	1	2	1	....	....	....	....	....	....	1	3	....	4
Antrim	1	....	1	....	....	....	....	....	....	1	....	....	....	....	1	....	....	1
Ashland	12	3	9	....	....	2	6	1	1	....	2	....	....	....	6	6	....	14
Barrington	3	1	2	....	....	....	2	1	....	....	....	....	....	....	....	3	....	3
Bartlett	3	3	....	....	....	....	2	1	....	....	....	....	....	....	2	1	....	3
Bath	1	....	1	....	....	....	....	1	....	....	....	....	....	....	1	....	....	2
Bennington	1	1	....	....	....	....	....	....	1	....	....	....	....	....	....	1	....	1
Berlin	20	12	8	....	....	1	6	8	2	2	....	....	....	1	6	14	....	22
Bethlehem	10	6	4	....	....	1	4	3	2	....	....	....	....	....	4	6	....	13
Bradford	6	3	3	....	....	4	2	....	....	....	....	....	....	....	4	2	....	6
Bristol	20	5	15	....	1	4	2	3	1	6	1	2	....	....	8	12	....	21
Brookline	4	1	3	....	....	....	....	....	1	....	....	....	....	3	1	2	1	5
Candia	1	1	....	....	....	....	....	1	....	....	....	....	....	....	1	....	....	1
Charlestown	2	1	1	....	....	....	2	....	....	....	....	....	....	....	1	1	....	2
Claremont	13	3	9	1	1	2	4	5	....	1	....	....	....	....	5	8	....	14
Colebrook	5	2	3	....	....	1	4	....	....	....	....	....	....	....	1	4	....	5
Concord	189	65	124	....	2	13	44	41	18	12	8	1	....	50	91	88	10	237
Conway	4	2	2	....	....	....	....	2	2	....	....	....	....	....	1	3	....	4
Deerfield	1	1	....	....	....	....	....	1	....	....	....	....	....	....	1	....	....	1
Dover	26	7	19	....	....	....	10	3	7	3	2	1	....	....	10	16	....	30
Enfield	3	3	....	....	....	....	....	1	2	....	....	....	....	....	1	2	....	7
Epping	3	2	1	....	....	....	1	....	....	1	1	....	....	....	....	3	....	6
Epsom	2	2	....	....	1	....	....	....	....	1	....	....	....	....	1	1	....	2
Exeter	22	6	16	....	1	4	12	1	2	....	2	....	....	....	13	9	....	25
Farmington	8	5	3	....	....	1	2	2	3	....	....	....	....	....	3	5	....	11
Fitzwilliam	3	2	1	....	....	....	1	....	....	1	....	....	....	1	2	....	1	3
Franconia	2	....	2	....	....	....	1	....	....	1	....	....	....	....	2	....	....	2
Franklin	29	12	17	....	2	2	9	8	....	1	6	....	....	1	6	23	....	38
Fremont	2	1	1	....	....	1	1	....	....	....	....	....	....	....	1	1	....	2
Goffstown	8	3	5	....	....	....	2	1	2	2	1	....	....	....	5	3	....	8
Gorham	2	1	1	....	....	1	1	....	....	....	....	....	....	....	1	1	....	3
Grantham	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	1	....	1
Greenland	12	6	6	....	....	....	2	6	2	1	1	....	....	....	3	9	....	30
Hampton	3	1	2	....	....	....	2	1	....	....	....	....	....	....	3	....	....	3
Hanover	74	8	66	....	1	6	35	11	4	5	4	2	....	6	47	27	....	87
Harrisville	2	2	....	....	....	....	1	1	....	....	....	....	....	....	....	2	....	2
Haverhill	11	5	6	....	1	1	4	4	....	....	....	....	....	1	5	5	1	14
Hill	1	....	1	....	....	....	1	....	....	....	....	....	....	....	....	1	....	2
Hillsborough	7	2	5	....	....	1	1	1	1	1	1	....	....	1	4	2	1	7
Hinsdale	1	....	1	....	....	....	....	....	....	....	....	....	....	1	1	....	....	1
Hudson	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	1	....	2
Keene	16	4	12	....	....	3	4	7	....	2	....	....	....	....	8	8	....	18
Laconia	12	4	8	....	....	3	3	3	....	....	1	....	1	1	4	7	1	12
Lancaster	5	3	2	....	....	....	3	1	....	1	....	....	....	....	3	2	....	5
Lebanon	20	6	13	1	1	1	6	6	4	....	....	....	....	2	7	12	1	29
Lisbon	19	12	7	....	....	3	5	5	1	3	....	1	....	1	8	11	....	23
Littleton	13	5	8	....	....	1	4	2	2	....	....	....	....	4	7	4	2	14
Londonderry	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	1	....	1
Loudon	1	....	1	....	1	....	....	....	....	....	....	....	....	....	1	....	....	1
Lyme	6	3	3	....	....	....	....	2	3	....	....	....	....	1	1	5	....	6
Manchester	65	34	31	....	6	7	23	12	10	4	1	....	....	2	31	33	1	81
Marlborough	1	....	1	....	....	1	....	....	....	....	....	....	....	....	....	1	....	1
Meredith	2	1	1	....	....	....	1	....	....	....	....	....	....	1	1	....	1	2
Milan	2	....	2	....	....	....	....	....	....	2	....	....	....	....	2	....	....	2
Milford	1	1	....	....	....	....	....	1	....	....	....	....	....	....	....	1	....	1
Monroe	1	....	1	....	....	....	....	1	....	....	....	....	....	....	1	....	....	1
Nashua	75	31	43	1	2	12	29	17	7	1	3	....	....	4	27	44	4	86
New Boston	2	....	2	....	1	....	....	....	....	....	....	1	....	....	....	2	....	2
New Hampton	2	....	2	....	....	....	....	....	....	....	....	....	....	2	....	2	....	2
New London	1	1	....	....	....	....	....	1	....	....	....	....	....	....	1	....	....	1
Newport	14	4	10	....	1	3	3	4	2	....	....	....	....	1	6	8	....	16
Northumberland	2	1	1	....	....	....	....	1	....	1	....	....	....	....	2	....	....	3
Northwood	3	....	3	....	....	2	....	....	....	....	....	1	....	....	1	2	....	3
Nottingham	2	2	....	....	....	....	1	1	....	....	....	....	....	....	1	1	....	2
Orford	1	1	....	....	....	....	....	1	....	....	....	....	....	....	1	....	....	1
Ossipee	4	2	2	....	....	....	2	....	....	....	....	....	....	2	3	1	....	5
Pittsfield	6	2	4	....	1	1	....	3	1	....	....	....	....	....	2	4	....	6
Plainfield	2	1	1	....	....	....	1	....	....	....	1	....	....	....	2	....	....	2
Plymouth	4	3	1	....	....	....	....	....	3	1	....	....	....	....	3	1	....	5

Specimens of Sputum Examined.— Continued.

CITY OR TOWN.	Number of cases examined.	Positive.	Negative.	Doubtful.	1 to 10.	10 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.	Age not stated.	Male.	Female.	Not stated.	Number of examinations.
Portsmouth	19	8	11	....	....	3	3	3	7	1	1	....	....	1	8	10	1	28
Raymond	1	....	1	....	....	....	1	....	....	....	....	....	....	....	1	....	....	1
Rochester	28	15	13	....	....	3	3	3	6	3	7	....	....	3	15	12	1	30
Rumney	2	....	2	..	1	....	....	....	....	1	....	....	....	....	....	2	....	3
Rye	3	3	....	....	....	....	....	3	....	....	....	....	....	....	2	1	....	3
Salem	1	1	....	....	....	....	....	....	....	1	....	....	....	....	1	....	..	1
Salisbury	1	....	1	....	..	..	....	..	....	....	....	....	....	1	1	....	....	1
Seabrook	1	1	....	....	....	....	1	....	....	....	....	....	....	....	1	....	....	1
Somersworth	22	11	11	....	....	3	7	5	4	1	2	....	....	....	10	12	....	30
Springfield	2	1	1	....	....	....	1	....	....	....	....	....	....	1	1	....	1	2
Stewartstown	1	....	1	....	....	....	....	1	....	....	....	....	....	....	....	1	....	1
Sunapee	5	2	3	....	1	1	2	....	....	1	....	....	....	....	1	4	....	6
Sutton	4	2	2	....	....	....	1	....	....	1	....	....	....	2	1	3	....	6
Tilton	10	2	8	....	1	....	2	3	2	....	....	2	....	....	4	6	....	11
Troy	1	1	....	....	....	....	....	....	....	....	1	....	....	....	1	....	....	1
Wakefield	1	....	1	....	....	....	....	1	....	....	....	....	....	..	1	....	....	1
Walpole	5	2	3	....	....	....	....	1	1	....	1	1	....	1	2	3	....	5
Warner	2	....	2	....	....	....	....	....	....	....	....	....	....	2	....	1	1	2
Warren	3	....	3	....	....	....	....	2	1	....	....	....	....	....	2	1	....	3
Washington	1	....	1	....	....	1	....	....	....	....	....	....	....	....	....	1	....	1
Webster	1	....	1	....	....	1	....	....	....	....	....	....	....	....	....	1	....	1
Whitefield	4	....	4	....	....	....	1	3	....	....	....	....	....	....	3	1	....	6
Wilton	3	2	1	....	....	....	....	1	1	..	1	....	....	....	1	2	....	3
Winchester	1	1	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	1
Wolfeborough	1	....	1	....	....	....	....	....	....	....	1	....	....	....	....	1	....	1
Total	957	368	586	3	26	99	283	209	111	65	52	12	1	99	432	496	29	1,158

It will be seen by the above table that sputum was sent from ninety-seven cities and towns in the state. Examinations were made in a total of 957 cases, or different individuals, while the total number of bacteriological examinations was 1,158. Of the 957 different cases 368 showed the presence of the tubercle bacilli, 586 negative results, and 3 doubtful.

The ages of persons from whom sputum was received were as follows: Between 1 and 10, 26; between 10 and 20, 99; between 20 and 30, 283; between 30 and 40, 209; between 40 and 50, 111; between 50 and 60, 65; between 60 and 70, 52; between 70 and 80, 12; between 80 and 90, 1; and in 99 instances the age was not given.

Sex was as follows: Males, 432; females, 496; sex not stated, 29.

INTERPRETATION OF BACTERIOLOGICAL EXAMINATIONS.

POSITIVE RESULTS.—It is to be presumed that, in all cases where sputum has been sent to the laboratory for bacteriological examination, there exists in the mind of the attending physician a suspicion of tuberculosis, otherwise he would not go to the trouble of obtaining and sending a sample of sputum to the laboratory; so it may be safely assumed that when the tubercle bacilli are found in such specimens the person is suffering from the disease. Very rarely a few bacilli may perhaps be

found in the mouths of healthy persons; but examinations from such patients are not likely to be made except, possibly, in the instance of other persons, where there is a case of tuberculosis in the family, and even then rarely done, so that the presumption that the person from whose sputum the tubercle bacilli are obtained has tuberculosis. It is therefore reasonably safe to presume that the 368 persons in which the tubercle bacilli were found had some form of tuberculosis.

NEGATIVE RESULTS.—A single negative result does not prove that the tubercle bacilli do not exist in that case, and should not be considered of any importance to the physician; in fact, should several successive negative results be obtained, proof would still be lacking that the patient might not be infected with the disease, and especially should such results be considered as valueless in the event that there are present in the person some clinical evidences of tuberculosis.

Negative results may be obtained under several conditions in cases where the disease exists, especially when it is present in a chronic form, or is of that type known as miliary tuberculosis.

Among the other causes for such results may be mentioned an improper collection of the sputum; the entire absence of the bacilli in the sputum, a result often obtained in cases where there is very little or no breaking down of the lung tissue so as to allow the escape of the bacilli into the sputum; and, furthermore, the bacilli might be present in very small numbers and escape observation under the microscope. Where there is strong clinical evidence of tuberculosis, a single negative result should never change the opinion of the attending physician. Successive examinations should be made from time to time, weekly or monthly, as may be deemed best, until there is a reasonable certainty in the case, although no number of negative results should be permitted to counterbalance in any manner well defined clinical indications of the disease.

DIPHTHERIA.—BACTERIOLOGICAL WORK.

OUTFITS.—A careful consideration was given to the subject of outfits for the collection of specimens in suspected cases of diphtheria. Two methods were found to be in use,—one in which two tubes were used, one containing serum for the growth of the diphtheria bacilli, and the other a swab, and in some instances two swabs, for the purpose of entrapping the bacilli, and then smearing upon the serum in the other tube. In situations in which this method can be constantly supervised and fresh serum tubes substituted for those which become dried, the system is probably the best in existence. The difficulties, however, are so great, by reason of the drying of the serum where these outfits are placed on deposit and not used for some time, that it would seem to be almost impracticable for general state use.

The outfit which was decided upon for our own use, and which is also used with gratifying success in some other states, consists of a single glass tube in which is placed a wire about four inches in length, with cotton swab on the end, the tube plugged with absorbent cotton and closed with rubber cap, all of which is sterilized before being sent out. This tube is placed in a cylindrical wooden screw-cap tube, with directions for taking the specimen, blank upon which to report case, and a piece of gummed paper for the purpose of sealing the case after the specimen has been collected, and the tube replaced. On the outside of the cylindrical wooden shipping case above mentioned is pasted a shipping label, all specimens being sent by express or messenger. When the outfit is sent out from the laboratory, all complete as above described, it is inclosed in a wrapper upon which is the following:

DIPHTHERIA OUTFIT.

FROM N. H. LABORATORY OF HYGIENE.

NOTICE.—The test tube, swab, etc., in this outfit have been carefully sterilized, and should not be uncapped until the physician is ready to take the specimen from the patient's throat.

The inclosed directions must be followed explicitly. Remove this outer wrapper before attempting to open.

The specimen must be sent by express or messenger (not by mail) to the laboratory either at Concord or Hanover, as may be most convenient.

It will be seen that special efforts are made to put up the entire outfit in such a manner as to insure its delivery to the physician intact, and with such explicit directions that no mistake shall be made.

BLANK.—The blank which is inclosed with the outfit asks for a certain amount of information concerning the case, and also gives directions for taking the specimen, as will be seen:

DIPHTHERIA.

Specimen for Examination.

THIS BLANK MUST BE FILLED IN EVERY CASE.

Doctor's name.....
City or town.....
Patient's name.....
Residence..... Age..... Sex.....
No. of specimen: 1st, 2d, 3d, 4th, 5th, 6th, 7th.....
Date of earliest symptoms.....Date culture taken.....
How contracted.....
Location of membrane.....
Was an antiseptic applied to throat within two hours?.....
.....
No. in family? Adults.....Children.....
Clinical diagnosis.....

Return This Blank, Filled Out, with the Specimen.

All charges for transmission must be paid by the party sending the specimen; and also telegraph or telephone charges in reporting results. Shall report be sent by mail, telegraph, or telephone?.....

Send Specimen to Concord or Hanover, as may be most convenient.

Received.....
Incubator .....
Result .....
Reported .....
Mail, Telephone, Telegraph.
Remarks:
.....
.....
.....
.....
.....
.....

New Hampshire State Board of Health.

Laboratory of Hygiene.

DIRECTIONS FOR TAKING SPECIMENS.

The patient should be placed in a good light, and, if a child, held properly. In cases where it is possible to get a good view of the throat, depress the tongue and rub the cotton swab gently, *but freely*, against any visible exudate, *revolving the wire between the fingers*, so as to bring all portions of the swab in contact with the mucous membrane or exudate. In other cases,

including those in which the exudate is confined to the larynx, *avoiding the tongue*, pass the swab back as far as possible, and rub it freely as described above against the mucous membrane of the pharynx and tonsils. Then carefully replace the swab in tube, plug with the cotton, cover with rubber cap in the same manner as it was originally, wrap this blank (after being carefully filled out) around the tube, place in wooden case, screw together firmly, seal with the small strip of adhesive paper, and forward by express, prepaid, as per label, either to Concord or to Hanover, as may be most convenient.

Unsatisfactory cultures, exhibiting insufficient growth or contamination by foreign bacteria, usually result from failure to follow carefully the above directions. A report will be forwarded as soon as possible by mail, telegraph, or telephone.

Reason for Certain Questions.—Occasionally some physicians have sent the blank accompanying the specimen to the laboratory without having properly filled the same. In all cases such blanks will be returned for correction. The laboratory asks for the data for the purpose of compiling certain facts in connection with the work, such as are revealed in the accompanying table. It will be readily seen that, as an illustration of the point which we wish to make, if the patient's name is not given it will be impossible to identify the case in preparing tables, and likewise the number of the examination.

Certain other questions are for practical sanitary reasons, even though the object may not be apparent to every person. The facts given in an individual case might be as such valueless, but when taken in connection with all other cases important deductions can be made, and this is why it is insisted that the blanks sent out in connection with bacteriological examinations for suspected cases of tuberculosis, diphtheria, typhoid fever, malaria, etc., shall be filled.

Examination of Specimens.—Arrangements have been made with the American Express Company by which all specimens received up to 9 o'clock P. M. will be delivered the same evening, so that they may be placed at once in the incubator to remain over night for examination the following morning.

The usual process is to uncap the tube immediately, take out the swab and smear it upon freshly prepared serum already in sterilized tubes, and place the latter in the incubator to secure the growth of the bacilli. In extremely urgent cases we have sometimes been able to discover the germ of the disease by microscopic examination of the swab itself, immediately upon arrival, but this procedure is too uncertain in its results to be employed as a general practice.

Report to Physicians.—The culture is removed from the incubator in the morning, and an examination made to see what growth has developed during the night. As soon as the result of the examination has been

determined, a report is made to the physician by mail, telegraph, or telephone, as he has requested. The official report of the bacteriologist is made upon the following blank:

Laboratory No.....

LABORATORY OF HYGIENE,

NEW HAMPSHIRE STATE BOARD OF HEALTH.

BACTERIOLOGICAL DEPARTMENT.

.....N. H.,.....190....

DR.....

.....

DEAR DOCTOR:

The examination of the culture made by inoculating blood serum with the material found on the swab from the throat of.....

.....

on.....shows does not show the presence of the diphtheria bacilli.

Remarks:

.....

.....

.....

.....M. D.,

Bacteriologist.

IRVING A. WATSON, M. D.,
Director of Laboratory.

It will be noted in the blank above that the report does not say that diphtheria exists or does not exist, but simply that the examination shows, or does not show, the presence of the diphtheria bacilli. Notwithstanding that much has been written upon the subject of negative results, we have found that some physicians have placed reliance upon a single negative report, which should never be done. It has been the practice in making reports to state under "remarks" that there was no growth, or that other forms of bacterial infection were found, according to the facts revealed. The interpretation, and some other points in connection with bacteriology of diphtheria and other anginas, will be referred to elsewhere.

REPORT OF EXAMINATIONS IN CASES OF SUSPECTED DIPHTHERIA.

In the table given below are embraced data concerning bacteriological examinations made in cases of suspected diphtheria. It will be seen that 1,185 specimens were examined during the period embraced in this report, taken from 824 individuals. The cases were reported from seventy-two towns and cities in the state. The results of the examinations are given under appropriate headings.

Diphtheria.

CITY OR TOWN.	Number of individual cases.	Number of specimens sent.	First negative.	Second negative.	Third negative.	First positive.	Second positive.	Third positive.	Subsequent examinations.	First negative and second positive.	KIND OF INFECTION. Streptococcus.	Staphylococcus.	Diplococcus.	Bacillus subtilis.
Andover	11	17	7	1	1	3	2	1	2	....	2	1	....	....
Antrim	3	3	2	...	....	1	....	....	...	....	1	....	..	....
Ashland	1	1	....	....	....	1	....	....	....	....	....	....	....	....
Belmont	4	4	4	....	....	..	....	....	....	....	1	3	....	....
Bennington	4	4	3	....	....	1	....	....	....	....	....	....	....	....
Berlin	10	10	6	....	....	4	....	..	....	....	2	3	1	....
Boscawen	6	10	4	1	1	2	1	...	1	....	1	1	....	....
Bristol	7	9	4	2	....	3	..	....	....	....	1	....	....	....
Campton	2	2	2	..	....	....	....	....	....	..	1	....	....	....
Canaan	4	4	2	....	....	2	....	....	....	....	....	....	....	....
Canterbury	1	5	...	1	....	1	....	1	2	....	....	....	....	....
Center Harbor	4	4	4	....	....	..	....	....	....	....	4	....	....	....
Chester	3	6	1	3	....	2	....	....	....	....	1	1	....	..
Claremont	5	8	3	....	1	2	2	....	....	....	....	....	....	....
Colebrook	1	1	....	....	....	1	....	....	....	....	....	....	....	....
Concord	340	*598	294	68	46	63	29	16	82	†15	70	62	2	....
Conway	9	10	7	1	....	2	....	....	....	....	2	2	....	....
Dover	6	6	1	....	....	5	....	....	....	....	....	1	....	....
Enfield	4	5	4	1	....	....	....	....	....	....	....	....	....	....
Epping	7	8	2	1	....	5	....	....	....	....	2	....	....	....
Epsom	2	2	2	....	....	....	....	....	....	....	....	1	....	....
Exeter	4	4	3	....	....	1	....	....	....	....	2	....	....	....
Franconia	1	1	....	....	....	1	....	....	....	....	....	....	....	....
Franklin	36	55	27	7	2	10	4	2	3	2	16	6	....	....
Gilsum	1	3	...	1	....	1	1	....	....	....	....	....	....	....
Hampstead	2	2	1	....	....	1	....	....	....	....	....	1	....	....
Hanover	41	45	41	4	....	....	....	..	....	....	5	2	....	....
Haverhill	29	37	19	5	...	10	2	1	....	....	8	6	....	....
Henniker	2	2	1	....	....	1	....	....	....	....	....	....	....	....
Hill	1	1	...	....	....	1	....	....	....	....	....	....	....	....
Hinsdale	3	3	1	....	....	2	....	....	....	....	1	....	....	...
Hopkinton	1	1	1	....	....	..	....	....	....	....	1	....	....	....
Hudson	3	3	1	....	....	2	....	....	....	....	1	....	....	....
Jackson	2	2	1	....	....	1	....	....	....	....	....	....	....	....
Keene	13	18	10	2	1	4	1	....	....	..	2	1	....	....
Laconia	3	3	2	....	....	1	....	....	....	....	....	....	....	....
Lancaster	2	2	1	....	....	1	....	....	....	....	....	....	....	....
Lebanon	31	47	23	7	1	8	3	2	3	....	5	3	....	....
Lincoln	1	1	....	....	....	1	....	....	....	....	....	....	....	....
Lisbon	8	8	4	....	....	4	....	....	....	....	....	....	....	....
Littleton	5	8	1	2	1	4	....	....	....	....	....	....	....	1
Loudon	7	10	7	3	....	....	....	....	....	....	2	....	....	....
Lyme	1	1	1	....	....	....	....	....	....	....	....	....	....	....
Manchester	47	48	46	1	....	1	....	....	....	....	19	16	....	....
Monroe	2	3	2	1	....	....	....	....	....	....	1	....	....	....
Nashua	63	67	34	3	1	28	1	....	....	1	9	13	....	....
New Boston	2	3	3	....	....	....	....	....	....	....	....	....	....	....
New London	1	1	1	....	....	....	....	....	....	....	....	....	....	....
Newport	3	4	1	....	....	2	1	....	....	....	....	....	....	....
Northumberland	3	3	....	....	....	3	....	..	....	....	....	....	....	....
Northwood	2	5	1	....	....	1	1	1	1	....	....	....	....	....
Nottingham	2	2	2	....	....	....	....	....	....	....	....	2	....	....
Orford	2	3	2	....	....	1	....	....	....	....	....	..	....	....
Peterborough	10	10	5	....	....	5	....	....	....	....	2	1	....	....
Pittsfield	3	3	2	....	....	1	....	....	....	....	....	....	....	....
Plaistow	3	3	3	....	....	....	....	....	....	....	2	1	....	...
Plymouth	10	10	8	....	....	2	....	....	....	....	....	3	....	....
Portsmouth	10	10	7	....	....	3	....	....	....	....	5	1	....	....
Rochester	6	7	4	....	....	2	1	....	....	1	....	2	....	....
Rye	1	1	....	....	....	1	....	....	....	....	....	....	....	....

* Fifty-two negative examinations from throats of well persons in an institution where diphtheria had occurred. Six examinations, with positive results, of dust taken from the ventilator of a room in which a case of diphtheria had previously existed.

† In two cases first two examinations were negative and the third positive.

Diphtheria. — Continued.

CITY OR TOWN.	Number of individual cases.	Number of specimens sent.	First negative.	Second negative.	Third negative.	First positive.	Second positive.	Third positive.	Subsequent examinations.	First negative and second positive.	Kind of Infection.			
											Streptococcus.	Staphylococcus.	Diplococcus.	Bacillus subtilis.
Salem	1	1	..	....	....	1	....	....	....	....	....	....	....	....
Salisbury	4	7	3	2	1	1	....	....	....	....	....	1	....	....
Springfield	1	1	1	....	....	....	....	....	....	....	....	1	....	....
Stewartstown	4	6	....	....	....	4	2	....	....	....	....	....	....	....
Stratford	1	1	1	....	....	..	....	....	....	....	1	....	....	....
Swanzey	1	1	1	....	....	....	....	....	....	....	....	....	....	....
Tilton	1	1	1	....	....	....	....	....	....	....	....	....	....	....
Troy	1	1	1	....	....	....	....	....	....	....	1	....	....	....
Wentworth	2	2	2	....	....	....	....	....	....	....	1	....	....	....
Whitefield	2	2	1	....	....	1	....	....	....	....	....	1	....	....
Wilton	2	2	1	....	....	1	....	....	....	....	....	1	....	....
Woodstock	3	3	....	....	....	3	....	....	....	....	....	....	....	....
Total	824	1185	630	117	56	213	51	24	94	19	175	139	3	1

It will be seen that in the first examination 630 proved negative and 213 positive. In this large number of negative results were included many persons who were not suspected of having the disease, but who had been directly or indirectly exposed. It will, however, be seen in studying the table that in altogether too many instances reliance seems to have been placed upon one negative result, or, in other words, that either the physician was satisfied with such a report as being conclusive, or the case so rapidly improved within a day or so after forwarding the specimen as to remove the suspicion that the case was diphtheria.

The results, as far as the third examination, in the given case are carried out in their regular order; no numerical account is made of subsequent examinations, some of which were for release purposes. In a few cases of suspected diphtheria, some other form or forms of infection existed, as is noted in the table.

Many instances have come up during the work, of which we have special knowledge, where the diagnosis made by the laboratory proved of inestimable value in preventing wholesale exposure to the infection, and, as a consequence, doubtless limited the disease to a single case or family.

TYPHOID FEVER.

The Widal reaction for the determination of typhoid fever is, in a great majority of cases, satisfactory, there being only a small percentage of cases in which it is uncertain. The method, as well as further explanations concerning its reliability as a test, appears in the blank report returned to physicians, a copy of which is inserted in this report.

OUTFIT.—This consists of a short glass tube for the collection of a few drops of blood from the patient, sealing wax to close the tube, a blank upon which to report the case, and directions for taking a sample of the blood. These are all inclosed in a cylindrical wooden screw-cap case, with proper label for forwarding to the laboratory by mail; postage two cents.

The blank referred to is as follows:

TYPHOID FEVER.

SPECIMEN FOR EXAMINATION.

Doctor's name.....
City or town.....
Patient's name..... Age..... Sex.....
Occupation .....
Date of earliest symptoms.....Date specimen taken.....
Has patient previously had typhoid fever?.....
If so, where?.....
Present illness where contracted?.....
Has patient been away during the month previous to illness?.....
If so, how long ago?.....
Clinical diagnosis.....

RETURN THIS BLANK, FILLED OUT, WITH THE SPECIMEN.

All charges for transmission must be paid by the party sending the specimen; and also telegraph or telephone charges in reporting results. Shall report be sent by mail, telegraph, or telephone?.....

Send Specimen to Concord or Hanover, as may be most convenient.

Upon the reverse side of the above blank is the following:

Remarks:

.....
.....
.....
.....
.....
.....

NEW HAMPSHIRE STATE BOARD OF HEALTH.

LABORATORY OF HYGIENE.

DIRECTIONS FOR TAKING SPECIMENS OF BLOOD.

The skin covering the tip of the finger, or perhaps preferably the lobe of the ear, should be thoroughly cleansed and then pricked with a clean needle, or slightly incised so as to cause several drops of blood to exude. Four or five drops should be collected in the accompanying glass tube. It should then be carefully sealed with the sealing wax inclosed with tube for that purpose, then wrapped in cotton, or a piece of cloth, to prevent breakage, put into shipping case, cover screwed on tightly, and forwarded by express, *prepaid*, either to Concord or Hanover.

The blank on the reverse side of this sheet must be carefully filled by the attending physician. A report of the result of the examination, as soon as possible, will be sent in the manner directed.

An examination of the same is made as soon as practicable after it reaches the laboratory, and a report is mailed to the physician who sent the sample, upon the following blank:

Laboratory No.....

LABORATORY OF HYGIENE,

NEW HAMPSHIRE STATE BOARD OF HEALTH.

BACTERIOLOGICAL DEPARTMENT.

.....N. H.,.....190....

DR.....

.....

DEAR SIR:

The examination of the specimen of blood taken from.....

.....

.....

on.....shows does not show Widal's reaction when one part of blood serum is added to.....parts of a bouillon culture of the typhoid bacillus.

The serum test (Widal) for the diagnosis of typhoid fever is performed in the following way: One part of the suspected blood serum is added to one or more parts of a 24-hour bouillon culture of the typhoid bacillus. When the typhoid reaction appears, the bacilli quickly lose their motility and become clumped together in masses. The substances which cause this reaction are absent, or present to only a very moderate extent, in the blood of those not suffering from typhoid fever, while after the fifth day the blood of those having typhoid fever usually contains these agglutinating substances in abundance—in amounts greatly in excess of that found (except in the rarest instances) in the blood of those who have not, or have not had, typhoid fever.

The serum test, as seen from the above statement, is quantitative rather than qualitative. The examination should therefore not only determine the presence or absence of agglutinating substances, but their amount. The results so far obtained indicate that we are safe in drawing the following conclusions:

1st. That the patient in all probability has typhoid fever, or has had it within one year, in those cases in which the reaction occurs promptly upon the addition of one part of blood serum to nine parts of a bouillon culture of the typhoid bacillus.

2d. That if a marked reaction occurs when one part of blood serum is added to nineteen or more parts of a bouillon culture, the probability that the patient has typhoid fever becomes almost a certainty.

The agglutinating substances do not usually appear in the blood in sufficient amount to give the reaction until the fourth day of the disease. From the fourth to the seventh day of the disease specimens of blood serum from typhoid patients give the reaction in about 70 per cent; from the eighth to fourteenth day in about 80 per cent; and during the third and fourth weeks in about 90 per cent of the cases.

In from 5 to 10 per cent of the cases of typhoid fever the blood does not at any time in the course of the disease give a prompt and complete reaction, when one part of the blood serum is added to ten or more of the culture. The absence of the reaction in any individual case does not, therefore, positively exclude the diagnosis of typhoid fever.

.....M. D.,
Bacteriologist.

IRVING A. WATSON, M. D.,
Director of Laboratory.

INTERPRETATION OF RESULTS.—In addition to the opinions already expressed, the physician should make certain whether or not the patient had had typhoid fever, or an illness resembling that disease, in a recent period prior to the present illness, as in such case the infection sometimes exists for a considerable period. It would be necessary to exclude such possibilities, and this being done it could be safely assumed that a positive reaction indicated typhoid fever to a certainty. A negative result should be considered as of little or no importance in the case, for the reason that the Widal reaction does not usually develop before the fifth day, and may not until late in the disease, and is said not to be constantly present during all periods of the disease; so that both positive and negative reactions might be obtained during the continuance of the disease. It will be seen, therefore, that a negative reaction means nothing, while a positive reaction may, of course, be relied upon.

In the following table are given the results of examinations made at the laboratory from May, 1901, to October 1, 1902:

Typhoid Fever.

CITY OR TOWN.	Number of cases examined.	Positive.	Negative.	Doubtful.	1 to 10.	10 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.	Age not stated.	Male.	Female.	Not stated.	Number of examinations.
Acworth	1	1	...	...	...	1	...	...	...	...	...	...	...	...	1	..	...	1
Allenstown	3	...	3	...	...	...	1	...	1	1	...	...	...	...	2	1	...	3
Alstead	1	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	...	1
Barrington	1	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	...	1
Belmont	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	1	...	1
Bristol	2	1	1	...	2	...	...	...	...	...	...	...	...	...	...	2	...	2
Claremont	10	4	6	...	...	3	2	2	2	1	...	...	...	...	4	6	...	11
Concord	14	7	7	...	1	3	5	2	...	...	...	...	1	2	8	4	2	15
Dover	2	1	1	...	...	1	1	...	...	...	...	...	...	...	...	2	...	2
Franconia	1	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	...	1
Franklin	5	4	1	...	...	2	...	2	...	1	...	...	...	...	3	2	...	5
Hanover	11	3	8	...	...	2	6	2	1	...	...	...	...	...	8	3	...	13
Haverhill	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	1	...	1
Hillsborough	2	1	1	...	...	...	2	...	...	...	...	...	...	...	1	1	...	2
Hinsdale	3	2	1	...	...	1	2	...	...	...	...	...	...	...	1	2	...	4
Hudson	1	...	1	...	...	...	...	...	...	1	..	...	...	...	1	...	...	1
Keene	1	...	1	...	...	...	1	...	...	...	...	...	...	...	1	...	...	1
Lancaster	1	...	...	1	...	...	...	1	...	...	...	...	...	...	1	...	...	1
Lebanon	1	1	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	1
Lisbon	1	...	1	...	...	...	1	...	...	...	...	...	...	...	1	..	...	2
Littleton	2	...	2	...	...	1	...	1	...	...	...	...	...	...	1	1	...	2
Manchester	4	...	4	...	...	...	1	1	...	2	...	...	...	...	2	2	...	5
Meredith	1	1	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	1
Nashua	15	3	12	...	2	...	5	5	1	1	1	...	...	...	8	7	...	18
Newport	10	6	4	...	...	3	3	2	2	...	...	...	...	...	3	7	...	12
Portsmouth	1	1	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	1
Rochester	2	1	1	...	...	...	...	1	...	1	...	...	...	...	1	1	..	2
Seabrook	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	1	...	1
Somersworth	1	1	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	1
Swanzey	1	..	1	...	...	...	...	1	...	...	...	...	...	...	...	1	...	1
Tilton	1	1	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	1
Warren	1	1	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	1
Wilton	1	...	1	...	...	...	...	...	1	...	...	...	...	...	...	1	...	1
Winchester	2	1	1	...	...	...	...	1	...	1	...	...	...	...	1	1	...	2
Total	106	41	64	1	8	23	32	21	8	9	2	...	1	2	53	51	2	118

An examination of the above table shows that blood specimens were sent to the laboratory from 34 towns and cities, aggregating 106 cases, of which 41 gave a positive reaction, 64 a negative reaction, and 1 was classed as doubtful. The total number of examinations made was 118. The age and sex of patients are also given. In many instances the Widal reaction determines the diagnosis for the attending physician,—a matter of a great deal of importance, since in the event that the result is positive the physician and health officer are prepared to take such means as may be necessary to limit the spread of the disease. The physician is better prepared to treat his patient properly, and will, of course, see that proper disinfection of excreta, etc., is constantly maintained. It also suggests to the health officer the necessity of making a search for the source of infection. The great value of this test, of course, applies in cases where the diagnosis is uncertain. In a well-marked, typical case of typhoid fever the Widal reaction would not be necessary to determine the nature of the malady.

MALARIA.

OUTFIT.—The outfit for the collection of a sample of blood to be examined for the plasmodium of malaria consists of a small tin box with hinged cover, inside of which are placed two covered glasses to be used in accordance with directions, together with the following blank:

MALARIA.

BLOOD FROM A SUSPECTED CASE.

Doctor's name.....
City or town.....
Patient's name..... Age..... Sex.....
Occupation .....
Date of earliest symptoms.....Date specimen taken.....
Symptoms present.....
.....
.....
Probable source of infection, if any suspected.....
.....
.....
Date or season of last former attack, if any.....
Any quinine or other medicine administered before preparation of smears?
.....

RETURN THIS BLANK, FILLED OUT, WITH THE SPECIMEN.

All charges for transmission must be paid by the party sending the specimen; and also telegraph or telephone charges in reporting results. Shall report be sent by mail, telegraph, or telephone?.....

Send Specimen to Concord or Hanover, as may be most convenient.

This outfit may be sent by mail.

On the reverse side is the following:

Remarks:

.....
.....
.....
.....
.....

NEW HAMPSHIRE STATE BOARD OF HEALTH.

LABORATORY OF HYGIENE.

The tip of a finger or the lobe of one ear is thoroughly cleansed with soap and water and dried carefully. An ordinary surgeon's needle, previously passed through the flame of an alcohol lamp or a gas-burner, or held over

the chimney of a lighted kerosene lamp for a few seconds, to sterilize it, is used to prick the part until a small drop of blood exudes. This should be wiped away with a clean cloth and the second drop used. This is touched with the edge of a cover-glass, and the edge carrying the drop placed on a second cover at an angle of 20 to 30 degrees and drawn across its entire face. A thin smear or film of blood will be deposited on the second cover, which dries rapidly. *Three* or *four* such smears should be prepared if possible, each one from a freshly exuding drop, and laid down to dry. The points to be borne in mind in this operation are great cleanliness, rapidity of work, and the use of a fresh drop of blood, as the corpuscles shrivel soon, after exposure to the air.

The smear should be very thin, so that the corpuscles may be fixed almost instantly on the glass by drying. The thinner the smear, other things being equal, the more perfect the preservation of the corpuscles. A thin smear cannot be obtained from a large drop of blood. When the cover-glasses are thoroughly dry—usually in fifteen to thirty seconds—they are wrapped separately in the paper provided, and replaced in the box. This should be filled with the paper, so that the glasses cannot move about.

The best time for taking the blood is about eight hours before or after the chill. Smears prepared after the administration of quinine may not contain malarial parasites in numbers sufficient to be detected, and the microscopic diagnosis in such cases may be misleading. In a small percentage of cases of malaria, the blood from the skin may not at any one time contain parasites enough to be detected. Hence the non-discovery of these organisms in such rare cases does not negative the clinical diagnosis of malaria.

During the period embraced in this report only ten specimens of blood in cases of suspected malaria were sent to the laboratory. These were received from the following-named towns: Barrington, Dover, Hanover, Lancaster, Nashua, and Portsmouth. The malaria plasmodium was found in only one instance, the other specimens giving negative results.

PLACES WHERE BACTERIOLOGICAL OUTFITS MAY BE FOUND.

For the convenience of the physician who desires an outfit in the shortest possible time, we have established stations where these supplies may be found in different sections of the state. We have, in most instances, chosen drugstores suggested by physicians themselves, although when more places were named in a given locality than we deemed necessary we have selected one or more, and the physicians in the vicinity have been notified.

In some towns where no drugstore exists these supplies have been placed with some physician.

The profession have found this arrangement of great convenience and very satisfactory. Supplies are, however, mailed directly from the laboratory to the physician when so requested; but we prefer, for our own convenience, that they be obtained from the station in the physician's immediate vicinity.

Below is a list of stations:

Allenstown, supplied from Suncook.
Amherst, supplied from Milford.
Andover, supplied from Franklin Falls.
Antrim, Frank Dickey, druggist.
Ashland, W. F. Brown, druggist.
Belmont, E. C. Bean, druggist.
Berlin, Charles R. Denning, druggist.
Bethlehem, H. P. Smith, druggist.
Bristol, Fowler & Co., druggists.
Canaan, E. M. Allen, druggist.
Charlestown, George Nourse, druggist.
Claremont, George A. Briggs, druggist.
Colebrook, Charles S. Aldrich, druggist.
Concord, Arthur E. Clarke & Co., druggists; A. P. Fitch, druggist; Arthur H. Knowlton, druggist; George A. Berry, druggist.
Conway, G. W. Shaw, druggist.
Derry, West, H. Benson, druggist.
Dover, Lathrop & Pinkham, druggists.
Enfield, F. B. Williams, druggist.
Epping, A. C. Buswell, M. D.
Exeter, Weeks & Seward, druggists.
Farmington, W. J. Evans, druggist.
Franklin, Woodward Brothers, druggists.
Franklin Falls, George R. Kempl, druggist.

Goffstown, S. M. Johnson & Co., druggists.
Greenville, Dr. Charles E. Hall, druggist.
Groveton, John M. Wilson, druggist.
Hanover, Dr. H. N. Kingsford.
Haverhill (see Woodsville).
Henniker, W. N. Whitney, druggist.
Hillsborough, C. S. Perry & Co., druggists.
Hinsdale, Fred H. Jones, druggist.
Jaffrey, East, George H. Duncan, druggist.
Keene, Ballard & Shedd Co., druggists.
Laconia, J. H. Story, druggist.
Lakeport, Plummer & Thompson, druggists.
Lancaster, P. J. Noyes & Co., druggists.
Lebanon, Dr. I. N. Perley, druggist.
Lisbon, F. N. Kincaid, druggist.
Littleton, C. F. Davis & Co., druggists.
Manchester, Board of Health; L. G. Gilman, druggist; George A. Hanscom, druggist; Marshall & Knowlton, druggists; Potvin & Co., druggists; A. J. Precourt, druggist; F. H. Thurston, druggist; F. L. Way, druggist.
Meredith, C. W. Morrison, druggist.
Milford, W. F. French, druggist.
Milton, J. H. Willey, Ph. G., druggist.
Nashua, A. E. Wallace, druggist.
New Boston, F. A. Greer, druggist.
Newport, Fred E. Lovell, druggist.
Northwood Ridge, C. V. Fiske, M. D.
Ossipee, E. B. Andrews, M. D.
Pembroke, supplied from Suncook.
Penacook, C. H. Fowler, druggist.
Peterborough, George L. Forbush, druggist.
Pittsfield, V. A. Grant, druggist.
Plaistow, Edmund H. Noyes, M. D., chairman board of health.
Plymouth, Fred W. Brown, druggist.
Portsmouth, A. P. Preston, druggist.
Rochester, R. Dewitt Burnham, druggist.
Rollinsford (see Salmon Falls).
Salmon Falls, George W. Nutter, druggist.
Somersworth, Daniel J. Buckley, druggist.
Suncook, George E. Gordon & Co., druggists.
Tilton, C. P. Herrick, druggist.
Walpole, W. D. Knowlton & Co., druggists.
Warner, Kempl & Royder, druggists.

Whitefield, W. C. Leonard, druggist.
Wilton, W. I. Durgin, druggist.
Winchester, William W. Nash, druggist.
Wolfeborough, E. H. Thompson, druggist.
Woodsville, E. B. Mann & Co., druggists.

The outfits supplied at the above stations are those used in bacteriological work in connection with tuberculosis, diphtheria, typhoid fever, and malaria.

Containers for the collection of samples of water for chemical analysis must be obtained directly from the laboratory at Concord. We wish again to notify the public that it is useless to send samples of water collected in any but the bottles sent out from the laboratory, which in all instances are forwarded by express free of expense. Water sent in old bottles, jugs, or any other convenient receptacle will not be analyzed at the laboratory.

MISCELLANEOUS PAPERS ON VARIOUS SUBJECTS.

MISCELLANEOUS PAPERS.

REPORT ON DIPHTHERIA BACILLI IN WELL PERSONS.*

BY A COMMITTEE OF THE MASSACHUSETTS ASSOCIATION OF BOARDS OF HEALTH.†

FIRST PART.—EXECUTIVE.

Your committee when first appointed, July, 1900, attempted by a circular letter to learn what was being done in different American cities with well persons infected with diphtheria bacilli, and what were the views of the health officers as to the proper methods of controlling such cases. A summary of the replies received was presented at the association meeting held January 24, 1901. The replies showed that in only two cities, Baltimore and Providence, was a systematic attempt made to isolate well persons carrying diphtheria bacilli, that this rule applied chiefly to members of families in which clinical diphtheria existed, and that in Baltimore it applied chiefly to the school children in such families.

It was found that few data were available concerning the occurrence of diphtheria bacilli in well persons; and it was deemed advisable to institute, on a co-operative basis, an extended series of observations which would give us more accurate knowledge on this point. A circular letter asking for such co-operation was sent to about twenty bacteriologists. A number of favorable replies were received, and the following-named actually entered into the work:

Boston, Mass., Dr. H. W. Hill and Mr. B. R. Rickards, with Dr. A. A. Taft, and Drs. D. N. Blakely, W. S. Boardman, Paul Carson, John Duff, Theo. C. Erb, C. O. Kepler, C. Morton Smith, John T. Sullivan, and A. A. Wheeler.
Brookline, Mass., Dr. F. P. Denny.
Lowell, Mass., Dr. T. B. Smith.
Minnesota, Drs. F. F. Wesbrook, L. B. Wilson, O. McDaniel, and E. H. Beckman.
Newton, Mass., Dr. Arthur Hudson.
New York City, Dr. W. H. Park, with Dr. A. W. Williams.

*That is, "well" so far as the throat or nose is concerned.

†We reprint this valuable report from the Journal of the Massachusetts Association of Boards of Health. It comprises much original work by able and well qualified investigators, and is an important addition to the literature of the subject. I. A. W.

Ontario, Canada, Dr. J. A. Amyot.
Providence, R. I., Dr. C. V. Chapin and Prof. F. P. Gorham.
Springfield, Mass., Dr. H. C. Emerson.
Waltham, Mass., Dr. C. A. Willis, with Drs. W. E. Fernald, I. H. Ladd, and George L. Wallace.
Washington, D. C., Dr. W. C. Woodward and Dr. John E. Walsh.
Willard State Hospital, N. Y., Dr. W. A. Macy and Dr. Erving Holley.

The association will doubtless join the committee in expressing their thanks to those who, though some of them not members of the association, so willingly assisted in our undertaking.

The results of these investigations are given in detail in the second part of this report.

PREVALENCE OF DIPHTHERIA BACILLI IN WELL PERSONS.

Of the questions before the committee, the first which they have attempted to answer is, how frequently diphtheria bacilli are found in well persons.

All observers are not in accord as to the morphological appearances which are to be considered as characteristic of this organism. Some agree with Wesbrook in the belief that diphtheria bacilli are found to present all the forms named by him. Others admit the validity of only a portion of these types. Some do not believe that the so-called pseudo-diphtheria bacillus, the short solid-staining type, is a true diphtheria bacillus, while others are entirely satisfied that it should be classed with *B. diphtheriæ*.

In order to answer, from the collected data, the question of the degree of prevalence of diphtheria bacilli in well persons, it may be allowed to the different observers to state for themselves how many of their cultures they would, in the vernacular of the laboratory, have reported as "positive." Not all responded to this request.

In Boston, about 1 per cent were considered positive; in Brooklyn, 2.3 per cent; in Lowell, 1.2 per cent; in Springfield, 1.6 per cent; in Providence, 9 per cent; and in the District of Columbia, 22 per cent. These figures are chiefly interesting as indicating the divergent views of bacteriologists, and as explaining the widely different results hitherto obtained by different observers; although it is probable that the actual prevalence itself varies in different places to some extent.

Another way of stating the results of this work was for the committee to assume that certain forms would, by the majority of bacteriologists, be considered as diphtheria bacilli. The forms which the committee thinks would usually pass as diphtheria bacilli are Wesbrook's A, C, and D. On this basis it was found that 2.89 per cent of the total persons examined *(nose and throat)* were infected with diphtheria bacilli, or, leaving

out the returns from Minnesota, 1.39 per cent. It may be observed that the number reported positive did not correspond in all cases with the number of persons showing A, C, D.

The bacteriological examinations made by members of the committee and those who worked with them, except certain cases classified as "special," not included in the main tables, and many of the Minnesota results, were confined to persons who had not, so far as known, been recently exposed to diphtheria. When examination is made of the throats of those who have recently been in more or less direct contact with diphtheria, infection is found more frequently. No observations on this point were undertaken by the committee; but, from the investigations of Chapin, Denny, Kober, and Park, it is probable that from 8 to 50 per cent of the well persons in families where there is diphtheria are infected with the bacilli.

In institutions, particularly institutions for children, where diphtheria has prevailed, the infection appears often to become more general; and a considerable number of the children will often be found to have diphtheria bacilli in their throats or noses. Occasionally cases of true diphtheria develop, or perhaps marked outbreaks occur. Wesbrook reports such a condition in a school at Owatonna, Minn., and in Bethany Home, Minneapolis; a similar experience was met with in an orphan asylum in Providence. It is to be noted that the types on which this wide distribution was determined included many others besides A, C, and D, and that the diagnosis of a large part of the infection observed was based on the presence of the solid forms.

The committee feels justified in the inference that, in urban communities, at least 1 to 2 per cent of well persons among the general public are infected with the types A, C, and D, and that where well persons are exposed to diphtheria, as in families, schools, or institutions where cases exist, the number infected is much larger, and may range from 8 to 50 per cent.

The estimates just given in the last paragraph refer to the prevalence of the typical granular types of diphtheria bacilli. If the solid and barred types be also forms of this organism, it is very much more widely distributed than is above assumed. The question as to what should properly be considered diphtheria bacilli is discussed at length in the second portion of the report.

VIRULENCE OF THE DIPHTHERIA BACILLUS AS FOUND IN WELL PERSONS.

There is no doubt that even the most typical forms of diphtheria bacillus vary greatly in virulence and power to produce toxins. Oftentimes cultures will produce no constitutional symptoms when injected into guinea

pigs; and, as is well known, persons with morphologically typical bacilli in their throats may remain free from all clinical symptoms, and may mingle freely with others without spreading the disease.

It would be of decided advantage to know whether the bacilli found in well persons are usually virulent or not. There are two ways of determining this.

A. By the Guinea Pig Test.

The probable value of this test and the method of its application will be discussed in the second part of the report. Suffice it to say here that a sufficient number of tests have not been reported to the committee on which to base any very general conclusions. However, those that have been reported resulted as follows: Forty-seven pure cultures of Wesbrook's types A, C, and D, obtained from well persons, were inoculated into guinea pigs. Of these, 17 per cent were virulent. Of the types other than A, C, and D, thirty-nine inoculations were made; and 7.5 per cent proved to be virulent. All these latter positive results were from Providence. Gorham was the only observer to report virulent pure cultures of the solid-staining types C^2 or D^2. Wesbrook also at times has found these types virulent, but made no virulence tests in this particular investigation.

B. By Clinical Evidence.

We may perhaps learn from clinical experience whether well persons with bacilli in their noses or throats do really give the disease to others. A number of our correspondents have reported instances in which it seems very certain that this was the case. (Preliminary Report; Journal Massachusetts Association Boards of Health, January, 1901.) On the other hand, it may be argued that the bacilli carried by well persons are frequently, perhaps most frequently, non-virulent for two reasons: first, the persons themselves are not sick; and, second, diphtheria is not so common as it would be were virulent bacilli constantly distributed by the considerable number of infected well persons. If immunity, natural or acquired, be as widespread as stated by some authorities, these reasons would of course lose their weight.

The committee seems to be justified in concluding from an examination of the experimental and clinical evidence at hand that only a small percentage of the morphologically typical diphtheria bacilli found in well persons not recently exposed to the disease are virulent; but the number of infected individuals well enough to mingle freely with others is so great that, even if only a small proportion of them be likely to transmit the disease, there is in them a very important factor in the spread of diphtheria.

DANGER OF INFECTION FROM HEALTHY PERSONS.

The danger from a healthy person depends on the age, the habits, the surroundings, the occupation, and the intelligence of the infected person.

A child who is constantly putting his hands and everything else into his mouth, and who plays with susceptible children of similar habits, is more likely to spread the disease than an adult. Infected individuals of cleanly habits are less likely to disseminate bacilli than the uncleanly.

The danger from an infected person depends also on his surroundings, whether he comes in contact with other individuals in such a way that he is likely to infect them. Thus in a crowded tenement the opportunity for spreading the infection is much greater than it is in a private house. In institutions, infected persons are much more likely to spread the disease than elsewhere.

The occupation of the individual is very important. Thus persons who are engaged in handling articles of food (like milkmen) and those whose work brings them in close contact with small children (like nurses) are more likely to spread the disease than day laborers or clerks.

The intelligence of a person should be considered. An intelligent person can easily be taught to take a few simple precautions which will greatly reduce the risk of infecting others, without imposing any serious restrictions upon him. The manner in which the infection is spread can be explained to him. He can be taught to sterilize everything which comes in contact with the secretions of his mouth or nose, and to avoid sneezing, coughing, or even talking toward and in close proximity with another person. A few simple precautions of this sort, carried out by an intelligent person, will greatly lessen the danger of infection.

The danger from the rooms occupied by a healthy infected person is very slight. It is probably no greater than that of an electric car or any other much frequented public place into which some infected persons are undoubtedly coming very often.

CONCLUSIONS.

In the conclusions it is recognized that there are two classes of persons carrying diphtheria bacilli to be considered.

A.

There are scattered among the general public a considerable number of persons, not recently and directly exposed to the disease of diphtheria, who have typical diphtheria bacilli in their throats. Our observations show the average, for all places reporting, to be nearly as high as 3 per cent, or in the East 1.39 per cent. This would mean in Boston, if the

smaller figure be used, about 8,000 such cases. The mere statement of this fact shows how entirely futile it is to attempt to seek out and isolate the whole of this number. If this cannot be done, it is useless and unjust to isolate the small number that it may be possible to discover. The committee is therefore led to adopt the following as its first conclusion:

Conclusion I. It is impracticable to isolate well persons infected with diphtheria bacilli, if such persons have not, so far as known, been recently exposed to the disease.

If it happens that such cases come to the knowledge of the health officer, it would, however, be wise to give instructions in regard to caring for the secretions, thus placing a part of the responsibility of the case upon the infected person himself.

B.

It may be assumed, and with some show of probability, that the bacilli in well persons, recently exposed to diphtheria, are more likely to be virulent than are others, and it might be attempted to isolate all members of families where diphtheria exists, so long as the bacilli are found in the throat or nose; but there are difficulties in the way. Such a procedure would, in many cases, lengthen the period of the family isolation, and prove most exasperating to the family and to the medical attendant. Wage-earners, business and professional men, would be kept at home and away from important work. It is difficult to maintain the isolation of the patient during a long convalescence; but it is far more difficult to isolate a person who has not been sick at all. It is very difficult to persuade a man that he should remain at home because he has diphtheria bacilli in his throat, when one is obliged, in answer to his inquiry, to admit that there are hundreds of others going freely about, although infected like himself. It is usually useless to try to tell him that the conditions are different in his case, that his bacilli are derived from a recent case, and have been proved virulent. He will not accept the reasoning, and very likely his medical adviser will not accept it.

If, instead of a single throat culture, as is required in most places, two successive negatives from nose and throat are made necessary for release, the difficulties will be still further increased; and, if two negatives are not required, many infected will escape, and the object of the whole procedure will be defeated.*

Since the number of persons among the general public who are infected with diphtheria bacilli and who pass unrecognized and unrestrained may

* This method of keeping at home those members of families in which diphtheria exists who are infected with diphtheria bacilli was carried out very faithfully in Providence for a period of five years, but has been abandoned because it met with very decided opposition from both the laity and the medical profession; it should be noted that in Providence only one throat negative was required for release.

at any one time be greater than the number of infected persons in diphtheria families, it does not seem to be expedient to place restrictions upon the latter except when it can be done without causing much friction or hardship, or unless the danger in any particular instance can be shown to be very considerable.

The committee is therefore led to its second conclusion:

Conclusion II. It is not advisable as a matter of routine to isolate from the public all the well persons in infected families, schools, and institutions.

It is advisable to keep the children in infected families away from day school, Sunday school, and all public places, and that they should remain on their own premises, if possible.

Wage-earners may usually be allowed to continue their work; but teachers, nurses, and others who are brought in close contact with children should not be allowed to do so. Milkmen should not be allowed to continue their business.

When it is proposed to remove a well person from an infected family, it is not advisable to make the removal if diphtheria bacilli are present.

In schools and institutions it is usually advisable, if the infection is not too widespread, to separate from the others all infected persons, sick or well.

When diphtheria appears in a community which has for some time been free from it, it is advisable to isolate all persons who have been brought in contact with the patient until it shall have been shown that they are free from diphtheria bacilli.

While believing that it is not possible in the majority of cases to isolate well persons infected with diphtheria bacilli, we believe that the attempt should be made to educate the public to care for their persons and their secretions so as to avoid, as much as possible, the danger of infecting themselves or others. The committee would again call attention to the suggestions made at a former meeting for teaching cleanliness to school children, and similar advice might be profitably given to the members of families where diphtheria exists.

In thus putting before the association the results of both practical and experimental work concerning diphtheria bacilli in well persons, the committee does not wish to be understood as minimizing in any way the possible danger of bacilli-carriers to their environment. It has simply recommended what appears to be the most expedient course to pursue after considering the various conflicting interests of the public and the infected individual. The responsibility is largely shifted to the latter, and in the case of intelligent persons the individual responsibility in disseminating disease should be clearly placed before the infected person.

The various local health authorities, in accepting these suggestions, must necessarily exercise increased care, watchfulness, and discrimination, and should be prepared at any time whenever special circumstances warrant it to isolate any and all persons who are discovered with presumably virulent diphtheria bacilli.

SECOND PART.—BACTERIOLOGICAL.

The fact that diphtheria bacilli may, and frequently do, persist in the throat and nose of patients some time after recovery, and that even persons not clinically diseased may, in certain instances and for a variable period of time, harbor virulent bacilli, is entirely in harmony with our knowledge concerning the relation of disease germs to the individuals liable to their attack.

Before discussing its significance more in detail, it may be stated that the causal relation of the Klebs-Loeffler bacillus to what is clinically known as diphtheria is as firmly established as that of any of our well-known pathogenic bacteria to their respective diseases. This is based on the following facts:

1. The Klebs-Loeffler bacillus is the only species regularly present in diphtheria. It is most abundant at the height of the disease, and disappears soon after convalescence.

2. This bacillus produces a poisonous substance, or toxin, which after injection into animals produces inflammatory and hæmorrhagic œdemas, necrosis, or sloughing of tissues, and paralysis.

3. The antitoxin produced by the injection of the toxin is specifically preventive and curative.

The popular conception that disease germs enter, permeate, and then pass out of the body like an orderly army without stragglers is not confirmed by observation or experiment. There are two opposing forces in every infectious disease, and the variation in the resistance of the individual and in the virulence of the bacteria make the resultant disease a very variable quantity. The same is true of the final exit and destruction of bacteria after recovery, and leads to the inference, proved in a variety of diseases, that persons, to all appearances well, may carry disease germs. There is no basis for the belief that such bacteria are necessarily non-virulent. Their harmlessness to the carrier may simply be an expression of his immunity, either inherited or acquired at some earlier period through disease. Laboratory tests show clearly that such microbes, when identified as belonging to one or the other species of pathogenic bacteria, are, as a rule, of the usual virulence.

These organisms are frequently carried in such a way as to be easily shed, and hence to be a source of danger to others. Thus in chronic pulmonary tuberculosis a person may for years expectorate immense num-

bers of tubercle bacilli. In individuals who have recovered from typhoid fever the fæces, and particularly the urine, may contain typhoid bacilli for a time. Mild cases of typhoid, not recognized, may lead to epidemics. In Asiatic cholera the spirilla have been found in the stools of well persons living within the infected area. It is probable that in influenza the microbe may vegetate on the mucous membrane for some time after recovery. Lastly, it has been known for over twenty years that the diplococcus of croupous pneumonia flourishes on the mucous membrane of the throat of certain persons.

If we consider for a moment this list of pathogenic bacteria likely to survive the disease they produce, we find that they peculiarly represent those maladies having a starting-point, or producing lesions, in the mucous membranes. The diphtheria bacillus vegetates chiefly on the surface, sending its toxin inward, and this localization of the bacilli gives them a special opportunity to escape destruction by the body and to vegetate in immune individuals for a time. In fact, we need not be surprised if in the future more persons shall be found carrying these bacilli than the present figures indicate.

As there is no sharp line to be drawn between the healthy and the diseased state, one shading imperceptibly into the other, so there is no sharp line to be drawn, for many infections at least, between the time when the micro-organisms are still in the body and when they have all been destroyed or eliminated. It follows logically, as is shown by the work of certain members of this committee, that well persons may be at times the source of infectious diseases.

In the capacity of bacteriologists it becomes our duty to emphasize the facts that well persons may be the source of virulent disease germs, and that public health authorities cannot concentrate their attention on health and disease as such, but must take cognizance first and foremost of the whereabouts of disease germs; and in so doing they practically admit that the carrier of such germs, even if well, may be fitly compared to the spark which may or may not start a conflagration.

The measures to be carried out in dealing with individual carriers, when discovered, must be left for the health officers to devise. Such measures will naturally depend on the relative dangerousness of the disease involved, on the relative ease with which the bacteria may be disseminated, and, in fact, upon a number of conditions which do not come within the scope of the bacteriologist, but which must be settled on purely practical grounds.

TECHNICAL RESULTS.

The following is a report of the results of the investigations which have been carried out by the committee, together with a simple statement of

our present knowledge of the diphtheria bacilli found in healthy persons.

The chief objects of the investigations have been to determine: first, the frequency of the different forms of diphtheria-like bacilli in healthy persons; and, second, the virulence of the different forms.

A number of laboratory workers were asked to examine separate cultures from the nose and throat of healthy persons, to record, according to Wesbrook's classification, all the diphtheria-like bacilli which were found, to state whether or not they would report the cultures containing such forms as positive or negative if the cultures were taken for release, and finally to isolate these forms in pure culture and to test their virulence on guinea pigs.

The number of persons which have been examined and so recorded that they could be classified on the basis intended, is 3,953. They were as follows:

1. In the Minnesota State Board of Health Laboratory in Minneapolis, 1,154 children and adults in institutions.

2. In the Boston Board of Health Laboratory, 892 adults in prison and pauper institutions.

3. In the Providence Board of Health Laboratory, 541 school children, 376 tramps, 10 smallpox patients; total, 927.

4. In the Lowell Board of Health Laboratory, 250 cotton-mill hands.

5. In Washington, 205 children and adults in a hospital, and 16 health department officials; total, 221.

6. In Springfield, 64 school children, 121 male prisoners in jail; total, 185.

7. In the Brookline Board of Health Laboratory, 129 school children.

8. In the Willard State Hospital for the Insane, 82 inmates.

9. In the Newton Board of Health Laboratory, 63 women students at Wellesley College.

10. In Ontario, 50 patients and attendants in a general hospital.

The virulence of the bacilli in 86 cultures was tested.

In addition to the above, cultures from 1,536 persons were taken in Boston, Brookline, New York, and Waltham; but from the incompleteness of their records they could not be classified with the others, and are therefore grouped together under the head of "special cases."

The committee had hoped to have larger and more complete returns, and especially a larger number of examinations of persons living outside of institutions. Insufficient time and the inability to get permission to make cultures were the causes of this deficiency.

The work of tabulating the returns to show the relative frequency with which the different types were found in different places and in different classes of cases was very great, and was done by the secretary of the com-

mittee, Dr. Hibbert Winslow Hill. The tables in their final form were made largely by Dr. F. F. Wesbrook, who gave much time to this work. A few words in explanation of Wesbrook's classification of types of *B. diphtheriæ*.

WESBROOK'S CLASSIFICATION.—Wesbrook divides all the forms of diphtheria bacilli into three groups, according to their staining reactions. Those with deeply-staining granules he calls "granular forms," those with transverse bands "barred forms," and those staining evenly "solid forms." He further divides each of the groups into seven types according to shape and size. The types are designated by the letters A to G. Each individual type of the granular group is designated by a simple letter, A, B, C, etc.; the barred forms are called A^1, B^1, C^1, etc.; the solid forms are A^2, B^2, C^2, etc. The types are progressively smaller from A to G in each group.

The different types have been very well represented in plates which were published with Wesbrook's original article.* Through the courtesy of Dr. Wesbrook all the workers were furnished with these plates, so that they might be kept before them while making the examinations. In every culture showing diphtheria-like bacilli the forms present were recorded according to Wesbrook's types on charts which had been arranged by Dr. Wesbrook. We have found this classification to be a very rational one and very helpful in the work. It has made possible a comparison of results which could not have been accomplished in any other way. The difficulty in comparing the results hitherto obtained by different investigators has been that they have not classed as diphtheria bacilli the same types of bacilli. By the method of recording the types present, irrespective of personal views as to the propriety of classing the forms as true diphtheria bacilli, the question of what forms to consider as *B. diphtheriæ* is left to those who may make use of the results. The personal equation may thus be eliminated to a great extent.

This method has also given an opportunity to compare the relative frequency of the different forms of bacilli in different localities. The differences in some instances have been striking. The most marked are found between the results obtained in Minnesota and those in the laboratories in the East. While almost all the forms were more prevalent in Minnesota, the contrast is especially marked in the granular forms A, C, and D, which are nine to ten times as frequent there as they are in the East.

In considering such differences, allowance must be made for three variables:

*Transactions of the Association of American Physicians, 1900. Also see Minnesota State Board of Health Report, 1899-1900.

1. The personal equation of the observer, under which must be included technique of preparation, and classification.

2. The individuals from whom the specimens were obtained; whether they had been recently exposed to diphtheria or not; whether they were massed in such a way as to facilitate exchange of nose and throat contents.

3. Actual differences in locality, with the variables in conditions incident to this alone.

In the Minnesota examinations, cultures were taken almost altogether from children in institutions in which diphtheria had existed from one to eighteen months previously. This was unavoidable at the time when the investigations were asked for. It seems worthy of remark that in 316 day-school children (Park Rapids), from whom cultures were taken at the beginning of school in September, in a town where diphtheria had existed for eighteen months (this constituting the reason for the examination), the percentage of infection with types C, D, and A, was higher than that found in the East, and higher than in Brookline, where the 129 examinations listed were made under somewhat parallel conditions. It was, however, lower than that found in the other Minnesota examinations, except in a wholly diphtheria-free institution (Catholic Orphan Asylum) where the per cent affected approximated that found in Boston. This seems to bear directly on infection in general, indicating that infection is much more apt to be widespread amongst children in institutions than in day-school children.

As a further illustration of this variation of types in different localities, the results of the examinations of throat cultures by the New York City Board of Health show even a higher percentage of infection with the more generally recognized types of *B. diphtheriæ* (C, D, and A) than Minnesota. There had been more or less exposure in this case also. Further examples are afforded by three observations along somewhat different lines: 1. Gorham found that the types present in Providence in clinical diphtheria ran very considerably smaller than those in Boston (Hill) when actual comparison was made under similar conditions. 2. Wilson of Minnesota found branching forms of *B. diphtheriæ* in abundance in Boston, although they have been seen only three times in Minnesota. 3. Amyot of Ontario states that the types vary with the locality, to some extent, since, in studying clinical cases bacteriologically, he was able to distinguish between two specific localities by the types present.

The results in Minnesota* were so at variance with those obtained here that it seemed best to arrange them separately in the tables, particularly

*That the basis of opinion afforded by presence of types in actual practice in Minnesota is not different from that in other localities, is shown by the fact that the average duration of the quarantine period determined by the absence of diphtheria bacilli in two consecutive negative examinations is not greater in Minnesota than that in other localities.

as this report was intended primarily for the use of Massachusetts boards of health.

FREQUENCY OF THE OCCURRENCE OF WESBROOK'S TYPES OF BACILLI IN HEALTHY PERSONS, AND A CONSIDERATION OF THE EVIDENCE FOR THEIR RELATION TO DIPHTHERIA BACILLI.

GRANULAR FORMS.—A, C, and D are the forms most commonly present in clinical diphtheria,* and would be classed as diphtheria bacilli by all bacteriologists. One or more of these three forms were present in the nose in .93 per cent of persons examined in the East, or, including Minnesota, in 2.07 per cent. In the throat they were present in .61 per cent, or 1.46 per cent with Minnesota. Of all persons examined in the East, 1.39 per cent had these forms present in either throat or nose or both, or 2.89 per cent, including Minnesota. The other granular forms, B, E, F, and G, were seldom found in the East. Their relation to diphtheria bacilli is not settled.

BARRED FORMS.—These are said to be the only forms present in some clinical cases; but this condition must be rare, since some of the committee have never met such a case. They are said to be frequently present in the eye, where they are called the xerosis bacillus. If present in the eye, they can very easily pass through the lachrymal duct to the nose.

SOLID FORMS.—The bacilli of this group have protoplasm, which stains uniformly, and shows neither granules nor bars. In group A^2, B^2, and C^2 the rods occur singly; while D^2, E^2, F^2, and G^2 appear to be in pairs, often resembling two triangular or cone-shaped bodies with their bases together. These forms are found very frequently in the nose, as will be seen by an examination of the tables. For example, D^2 was present in the nose in 16.7 per cent of persons in the East, and 21.8 per cent, including Minnesota.

The relation of these solid types to diphtheria bacilli is still unsettled. They are sometimes met with as variants in pure cultures of diphtheria bacilli. Wesbrook and Gorham claim to have found them present alone in cases of clinical diphtheria. Both of these observers several times isolated solid forms in pure cultures from healthy persons, and proved them virulent to guinea pigs. Such a condition, however, must be very rare, as no other members of the committee have ever found these forms present alone in clinical diphtheria; and, when isolated by them from healthy persons, they have always proved to be non-virulent. Certain of the solid forms have characteristics which have been considered sufficient to differ-

*See also statistics of occurrence of A, C, D in clinical cases, Table XIII; also, Minnesota State Board of Health Report, 1899-1900.

entiate them from *B. diphtheriæ*. Thus, while the typical diphtheria bacillus has a very marked power of producing acid in dextrose bouillon, this property is entirely, or, at least, very often, absent in the most abundant solid forms, certainly those of the D^2 type. For this reason the solid forms are considered by many authorities not to be diphtheria bacilli at all, and are classed as pseudo-diphtheria bacilli or Hoffman's bacillus.

Others consider that these differences are not sufficient to separate them from true diphtheria bacilli. Thus Gorham believes that the changes in morphology are brought about by the action of the body fluids of an immune individual. Both he and Wesbrook find a gradual change from the granular to the solid forms during convalescence from the disease.

What types should be regarded as diphtheria bacilli? The committee believes that the question of the relation of these types to clinical diphtheria requires more investigation. The following statements, however, seem justified from the available evidence.

The large granular types are the ones most commonly present in cases of clinical diphtheria. They are found in about 1 to 2 per cent of well persons in this vicinity. The solid forms are very seldom present alone in cases of diphtheria, while they were found in about 20 to 25 per cent of all healthy persons. It is evident, therefore, that the granular types are the most important ones in the causation of diphtheria.

Whatever the relation of the solid types to diphtheria, whether they be true diphtheria bacilli or not, it is very obvious that they can be of little diagnostic value, being present as they are in so large a percentage of all healthy persons. Any attempt to base isolation on the presence of such types would be an injustice. Certainly, no restrictions whatever should be put upon a healthy person unless there are present in his nose or throat the forms of bacilli morphologically identical with those commonly seen in cases of diphtheria. In healthy persons, therefore, usually only the granular types, A, C, and D, should be recognized as diphtheria bacilli. We believe that the persons in whom these three forms are present represent almost all the individuals who are capable of infecting others.

It seems probable, in view of the results obtained by such reliable observers as Wesbrook and Gorham, that sometimes the solid forms, even when present alone, are true diphtheria bacilli; but we believe that this is so seldom the case that the number of persons who might be overlooked by neglecting these types would be very small.

The percentage of persons having the forms A, C, or D in the throat or nose is, as already stated, 1.39 per cent in the East, and 2.89 per cent, including Minnesota. These figures probably are not constant. Cultures from different classes of people would sometimes show different results. The results might be expected to vary in different years, depending in part on the prevalence of the disease of diphtheria and in part on factors as yet

unknown. It might be said that at the time these investigations were made (1901) diphtheria had been unusually prevalent. It seems reasonable, however, to suppose that in Massachusetts about 1 to 2 per cent of all persons carry typical diphtheria bacilli. Of this 1 to 2 per cent, not all are capable of transmitting the disease; for it is found that bacilli morphologically identical with diphtheria bacilli may have no power of producing toxins.

VIRULENCE OF THE DIPHTHERIA BACILLI FOUND IN HEALTHY PERSONS.

As there are differences of opinion in regard to the value of the guinea pig test for virulence, due in part to a misunderstanding of the nature of the test, a word in explanation of the method employed seems desirable.

The test is usually made by growing the diphtheria bacilli in bouillon. Soluble toxins are formed in the bouillon, if the bacilli are virulent; and this bouillon inoculated into guinea pigs produces local lesions and the death of the animal, even if all the bacilli have been removed by filtration. The test, therefore, is not to see if the bacilli produce toxins in the guinea pig, but whether they will produce them in the bouillon. If there are toxins in the bouillon, we know that they will produce the characteristic lesions in the guinea pig; for the effect of the diphtheria toxins on guinea pigs is so constant that this animal is taken as a standard of measure of the strength of diphtheria toxins and antitoxins. Practically, all diphtheria bacilli from clinical cases produce toxins in bouillon; and there is no reason to believe—although this cannot be proved—that the converse is not true, namely, that the bacilli which produce no toxins in bouillon will not produce them in human beings.

The number of virulence tests which were made in connection with these investigations was, unfortunately, small. More information on this point is needed.

Thirty-eight cultures of the solid forms were tested. In thirty-five the results were negative, while three showed virulence. The three positive tests were obtained by Gorham, reference to whose results has already been made.

One test of the barred forms was made. The result was negative.

Forty-seven tests of the granular forms were made. Thirty-nine proved to be non-virulent, eight (about 17 per cent) were virulent.

While these investigations show that about 1 to 2 per cent of all persons have typical Klebs-Loeffler bacilli, only about 17 per cent of this 1 to 2 per cent have virulent bacilli, or, in other words, 17 in 5,000 to 10,000 of all persons have diphtheria bacilli which are dangerous to the public health. The number of virulence tests was too small to make the above percentages of much value, yet they bring out the fact that, if a healthy

person is found to have Klebs-Loeffler bacilli, and there is no connection traceable between that person and cases of diphtheria, the chances are very much in favor of the bacilli being non-virulent. Great care should therefore be taken, we believe, not to put unnecessary restrictions on persons where the chances are great that the bacilli are non-virulent.

DIPHTHERIA BACILLI IN PERSONS EXPOSED TO THE DISEASE.

The investigations of the committee, except as already noted, do not cover the frequency of occurrence of diphtheria bacilli in exposed persons, but observations on this point are obtainable. Thus Park* found 50 per cent of children exposed in New York tenements to have Klebs-Loeffler bacilli. Chapin,† in Providence, finds 16 per cent of exposed persons to have the bacilli; Denny,‡ in Brookline, 13 per cent; Kober,§ in Breslau, 8 per cent.

It is found also that the bacilli in persons who have been in close contact with diphtheria are usually virulent. Thus Park in six cultures from exposed persons, Kober in fifteen, and Denny in seven, found all to be virulent.

From the above it is evident that the problem of what to do with a person who has been exposed to diphtheria is very different from what it is in the case of a non-exposed individual.

The bacilli found in healthy exposed persons are probably of the same virulence as those in the diseased individual, the absence of symptoms in the former being the result of an acquired or artificially produced immunity. A healthy person who has Klebs-Loeffler bacilli as a result of recent exposure is therefore as dangerous as a convalescent from diphtheria in whom the bacilli are persisting after all the local symptoms have disappeared.

It is therefore theoretically rational, if convalescents are isolated, to isolate also all healthy infected persons who have been exposed, until they are free from bacilli. Such a course would undoubtedly result in preventing the occurrence of some cases and in saving some lives. It is found, however, that such a course is not practicable for all boards of health to follow. It is largely an economic question. The risk to the public health must be weighed against the loss and privation to the individual from isolation.

(Signed)

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* American Text-book Practical Medicine, vol. i. p. 647.

† Reports of Superintendent of Health, Providence, R. I.

‡ Board of Health Report of Brookline, Mass., 1900.

§ Kober, Zeitschrift f. Hygiene, 1899, Bd. xxxi.

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(Dr. Wesbrook modifies his assent as follows: for Conclusion II he would substitute, "It may sometimes be impracticable to isolate from the public all the well persons in infected families, schools, and institutions, though it should be done as a routine if at all possible." He also adds, "Sometimes it is necessary to isolate, at least temporarily, patients who have sore throats in which types of bacilli not represented by A, C, and D are present.")

DIPHTHERIA FROM A BACTERIOLOGICAL POINT OF VIEW.*

BY IRVING A. WATSON, A. M., M. D.

It is a fact that the termination of a case of diphtheria cannot be prognosticated by the character of the bacilli; that the disease may be of the mildest or the most virulent type; that the bacilli may be present in the throats of healthy persons without doing them harm; that while the microscope may differentiate certain forms of the Klebs-Loeffler bacilli, experimental inoculations only can determine their virulence; that virulent bacilli sometimes produce only the mildest type of diphtheria; that a case clinically appearing to be diphtheria may be due to some other form of infection.

Strassburger, of Bonn, Germany, agrees with other observers that cultures from each case of diphtheria have a distinct toxin-producing power, and that this remains constant, even after a long period of time. In investigating an epidemic in his own city in which the fatality was unusually light, he isolated in pure cultures the bacilli from forty-seven cases, and in forty-three of the number he established the virulence of the bacilli by inoculative experiments. He also found that there was no special relation of virulence to the severity of clinical symptoms, and his conclusions were that the mildness of the epidemic had no relation to the virulence of the bacteria found, that it must be sought for in other causes.

Ernst says: "All of these investigations point to the same final conclusions: that the bacilli of diphtheria, even in the mildest cases, and without any clinical symptoms and also outside of the body, have a definitely stable virulence, and provided they fall upon suitable soil, are capable of setting up the so-called diphtheritic process, which is modified only by the physical condition of the person's organism so attacked."

In a tangle of seeming incongruities these writers, and others, have apparently lost sight of the actual value of the laboratory in differentiating the particular infection in clinical diphtheria.

Rupp,† in discussing these various phases in an ably written paper, throws perhaps unintentional discredit upon laboratory work in stating that "The routine bacteriological examinations as practiced at the present time in this city (New York) do not seem to be a help in the diagnosis of clinical diphtherias, nor do they help to prevent the spread of contagion."

Such an observation may lead some to believe that bacteriological examinations are next to worthless in themselves, and that the health department does not take notice of reported cases of diphtheria—an inference which we cannot believe was intended, but, nevertheless, the discredit thrown upon bacteriological work will be protested against both by clinicians and bacteriologists.

*Read before the New Hampshire Medical Society, May 16, 1902.
†Medical Record, November 9, 1901.

Whenever a bacteriological examination reveals the Klebs-Loeffler bacilli, the physician then knows positively that he has in hand a case of diphtheria, after which it becomes his duty to treat it as such, and to take no chances by waiting to ascertain through perhaps sad clinical experience the virulence of the bacilli. The health officer also is positively informed of the true nature of the disease, and he should take, immediately, the necessary precautions to prevent the spread of the malady.

The laboratory would have accomplished a function to its everlasting credit if it had done nothing more than to bring this early positive information to the physician and the health officer, however mild or virulent the case might be.

In discussing the subject of bacteriological diagnosis, Park says,* in speaking of the mild cases which it is difficult to differentiate, that bacteriological cultures "are of the utmost value, since they enable us to isolate those in which the bacilli are found, and to give preventative injections of antitoxin both to the sick and those in contact with them, if this has not already been done. As a rule, cultures do not give us as much information as to the gravity of the case as the clinical appearance, for by the end of twenty-four to forty-eight hours the extent of the disease is usually easy of determination."

The Bulletin of the Delaware Bacteriological and Pathological Laboratory, in discussing the importance of bacteriological examinations with respect to making positive diagnosis in suspected cases of diphtheria, says: "The value of such examinations is incalculable. If the physician sends to the laboratory a cotton swab which has been rubbed over the membrane or inflamed portion of the throat, the laboratory may or may not prove the presence of true diphtheria. If the result is positive the case is one of diphtheria, and is at once to be treated with antitoxin and isolated to prevent infection of others. If, on the other hand, the case is negative, the antitoxin treatment would be useless. Thus the physician knows exactly what to do, and works with a scientific certainty.

"Again, it has been found that certain forms of mild sore throat, which few physicians would easily recognize as diphtheria, are often associated with the presence of diphtheria germs. The true nature of such cases needs to be recognized, and the laboratory alone can settle the question."

Fussell, in discussing the value of throat cultures in diphtheria, says† that it would seem to follow that Klebs-Loeffler bacillus must always be found in a culture made from diphtheria, and conversely, in membranous exudates which are not true diphtheria, Klebs-Loeffler bacillus should

*Note: Bacteriology in Medicine and Surgery, page 377.

†Journal of the American Medical Association, November 16, 1901.

never be found, and that this proposition is true in a vast majority of cases; but not always so. Even in a case of true diphtheria the bacillus may not grow in the culture made, and, secondly, that sometimes a bacillus that is extremely like that of true diphtheria, if not so, is found.

Another condition which he says he believes discredits, to a certain extent, the results of a bacteriological examination is to be found in those cases in which there are no classical, clinical signs of diphtheria, but in which true, active, virulent diphtheria bacilli are found, and that this class of cases is large.

Jacobi recognized this when he said: "There are more cases of diphtheria walking our streets than are confined to the houses." While this assertion may, perhaps, be overdrawn, it illustrates the fact that he recognized walking cases of diphtheria as not at all uncommon.

Osler says:* "The presence of Klebs-Loeffler bacillus is regarded by bacteriologists as the sole criterion of true diphtheria, and as this organism may be associated with all grades of throat affections, from a simple catarrh to a sloughing, gangrenous process, it is evident that in many instances there will be a striking discrepancy between the clinical and the bacteriological diagnoses. One inestimable value of the recent studies has been the determination of the diphtheritic character of many milder forms of tonsilitis and pharyngitis."

Still further considering the diagnosis of diphtheria, he says:

"Where a bacteriological examination cannot be made, the practitioner must regard as suspicious all forms of throat affections in children, and carry out measures of isolation and disinfection. In this way alone can serious errors be avoided. It is not, of course, in the severer forms of membranous angina that mistake is likely to occur, but in the various lighter forms, many of which are in reality due to the Klebs-Loeffler bacillus."

Haven, in writing on the prevention of disease,† in reviewing diphtheria in its various phases, says: "It is impossible, too, to deal with diphtheria as it should be dealt with without the aid of bacteriology. This comparatively recent aid to diagnosis and control of the infective period, is, however, comparatively little used; yet it is only since we have had its assistance that we have been able to definitely decide that many cases of apparently simple sore throat are really diphtheria, and to recognize the infective nature of nasal cases without symptoms. The importance of being able to detect and deal with these ambulatory cases need hardly be pointed out, nor need the advantage of knowing when infection ceases; to these ends bacteriology is absolutely essential."

*The Principles and Practice of Medicine, Fourth Edition.

† Public Health (London), March, 1902.

OTHER INFECTIONS SIMULATING DIPHTHERIA.

It has been demonstrated by repeated bacteriological examinations, under conditions that insured the accuracy of the investigations, that many mild cases and some fatal ones having clinically the appearance, symptoms, etc., of diphtheria do not reveal the existence of the bacillus of diphtheria, but are due to some other form of infection. Cases appearing to be malignant diphtheria, terminating fatally, may result without the presence of the bacillus of diphtheria, the infection being due to some of the pyogenic cocci.

The streptococcus pyogenes is not only responsible for erysipelas, acute abscesses, septicæmia, puerperal fever, and many suppurative inflammations located in any or all parts of the human system, but it is, either alone or in conjunction with staphylococci, pneumococci, and perhaps other cocci and bacteria, the cause of many of the anginas, to determine which, or to exclude the bacillus of diphtheria, the bacteriological examination is imperative.

In the form of infection just referred to, the throat may present the false membrane, the systemic poison, the fetor of septic diphtheria, and yet the cause may be wholly free from diphtheritic infection.

The clinical symptoms of diphtheria which so frequently appear in scarlet fever, are almost always pseudo-membranous inflammations, resulting from the presence of streptococci. In fact we are safe in asserting, with our present knowledge of the subject, which has been obtained by long-continued and careful research by some of the ablest observers in this and other countries, that a certain diagnosis in the anginas cannot be made independently of the bacteriological determination of the form of infection.

Sternberg says:* "In certain forms of diphtheria, and especially when it occurs as a complication of scarlet fever, measles, and other diseases, the Klebs-Loeffler bacillus is absent, and a streptococcus, which appears to be identical with the streptococcus pyogenes, is found in considerable numbers, and is probably the cause of the diphtheritic inflammation."

In pelvic disturbances resulting in inflammatory or suppurative processes, gynecologists who avail themselves of the most recent advancement in treating this class of diseases, make use of bacteriological investigations to determine whether the infection is from gonococcus, staphylococcus, bacillus tuberculosis, colon bacillus, streptococcus, etc., for the purpose of guidance in the most efficient means of treatment.†

Equally important, if not, in fact, much more important, is it to determine the form of infection in the anginas for remedial purposes, to say nothing of limiting the infection of the disease.

*Text-Book of Bacteriology, Second Edition, page 225.

†Allaben. The American Gynecological and Obstetrical Journal, November, 1901.

NEGATIVE CULTURES.

In referring to this subject an eminent authority* already quoted says that "the reported absence of bacilli in a culture must be given weight in proportion to the skill with which the culture was made, the suitableness of the media, and the knowledge and experience of the one who examines it." He ought also to have added that the manner in which the swab is used to entrap the bacilli is an equally important matter. Continuing, he says:

"Diphtheria does not occur without the presence of the diphtheria bacilli; but there have been many cases of diphtheria in which, for one or another reason, no bacilli were found in the cultures by the examiner. In many of these cases later cultures revealed them.

"In a convalescent case the absence of bacilli in any one culture indicates that there are certainly not many bacilli left in the throat. Only repeated cultures can prove their total absence."

In discussing the subject of diphtheria Ernst says:† "The study of virulence has been made by a number of observers, and it was easily noted that even in acute cases the virulence differed in a marked degree, and it was further observed that absence of diphtheria bacilli in one culture did not suffice to prove that the bacilli might not be found, and be found virulent in a later culture."

Dr. H. W. Hill, director of the Boston bacteriological laboratory, in 1899 reported about four per cent of cases as negative on the first examination and positive on the second, and in commenting on this says that "a single negative result, and even occasionally two successive negative results, may be obtained from a case in which bacilli, nevertheless, are finally found."

Dr. George Blumer, director of the Bureau of Bacteriology and Pathology, New York, says:‡ "Do not rely on single samples of tuberculosis or diphtheria matter, but send others at intervals of a few days."

The number of bacilli in a very mild case of diphtheria, or at the first onset of the disease, in the throat of patients after all clinical symptoms of the disease have disappeared, or in a healthy infected throat, must necessarily be infinitely less than during the course of the disease, and they may be practically hidden in the folds, or follicles, of the mucous membrane, and for this reason negative cultures may be obtained primarily, or intervene between positive cultures.

*Park.

†Twenty-sixth Annual Report of the Health Department of the City of Boston, 1897, page 68.

‡Medical Review of Reviews, November 2, 1901, page 1016.

EXAMINATIONS FOR RELEASE OF QUARANTINE.

It is important for the patient, the family, and the health officer to know just when a case of diphtheria may without danger be released from quarantine.

It has been the custom in the past to fix an arbitrary period of from four to six weeks for the maintenance of quarantine, the maximum varying somewhat with the severity of the disease. This method is unscientific, and in its place should be substituted, as far as practicable, the culture method of determining when a case may be released.

The question of the virulence of the bacilli found in the throats of persons during convalescence, or immediately after recovery, is of considerable importance. In 1897, under the direction of Dr. Ernst,* culture tests were made in twenty-four cases that had been reported as positive for three weeks or more, and for which cases release was asked on the ground that the clinical symptoms had completely subsided. Inoculation experiments were made with guinea pigs, resulting in over 67 per cent of fatal cases, while others showed marked constitutional disturbances, and some of the animals were so sick that death was expected daily. A most virulent type of the disease was manifested in all but two of the cases.

Dr. W. H. Park, of New York, in a study of 605 cases to note the appearance of bacilli after the disappearance of clinical symptoms, says that in three or four cases they disappeared in three days; in 176 they persisted seven days; in 65, twelve days; in 36, fifteen days; in 12 cases, three weeks; and in 4 cases, five weeks.

Fowler and Wilson, in a circular of the New York board of health, 1896, stated that it was their observation that from the beginning of the disease, 30 per cent of the cases last three weeks or more; 15 per cent, four weeks or more.

Dr. Ernst found that of 909 diphtheria cases, but twenty-three patients were kept in quarantine over four weeks.

Additional statistics might be cited to prove the correctness of this position, but it would seem to be unnecessary.

INTERPRETATION OF RESULTS.

If a culture from the throat of a patient who appears, clinically, to have diphtheria, reveals the Klebs-Loeffler bacillus, there can be no question as to the diagnosis; but should the culture prove negative, instead of positive, the physician should in every instance regard the result as valueless, and should not permit it to warp his judgment or treatment of the case from a clinical point of view. The physician who relies upon a pri-

*Twenty-sixth Annual Report of the Health Department of the City of Boston, 1897, page 63.

mary negative result for a diagnosis of his case, may find himself in serious trouble, with, perhaps, a most malignant type of diphtheria on his hands a few days later.

We desire to impress this upon the profession, inasmuch as the experience at the New Hampshire Laboratory of Hygiene, covering over a thousand examinations in suspected cases of diphtheria within a year, shows that in a large percentage of those in which the primary examinations resulted negatively, a second culture was not taken, the physician evidently relying upon the first result, and believing it to be a sufficient guide. Or, if his case proved unfortunate, he charged it to the laboratory.

We believe that negative results should not be relied upon in any case of angina short of two or three examinations, made on successive days, and the culture taken in accordance with the directions issued, in order to prevent the specimen from being vitiated by the use of disinfectants immediately before it is taken, and that the operation may be properly performed.

Time does not permit a discussion of the morphology of certain bacteria associated with the various anginas, or the consideration of some other points in connection with the etiology of the various affections which closely simulate diphtheria; but we offer in conclusion the following propositions, as substantiated by clinical experience and bacteriological investigations:

1. That true diphtheria cannot exist without the presence of the Klebs-Loeffler bacillus, and that no case can be absolutely diagnosed as diphtheria until this bacillus has been demonstrated.

2. That membranous anginas of sufficient severity to cause death may be produced by the streptococcus pyogenes, the micrococcus of sputum septicæmia, and perhaps by other varieties of bacteria.

3. That without a bacteriological examination, the form of infection cannot be determined, or, in other words, the clinical appearance of a case does not always, if ever, reveal its true character, although presumably the clinical diagnosis is correct in a majority of cases.

4. That a bacteriological examination should be made in all cases when practicable, and that negative results should not be taken into account unless at least two or three are obtained on successive days.

5. That all cases having the clinical appearance of diphtheria should be treated as such from the beginning and until contra-indicated by successive negative examinations. It is, of course understood that one positive result is conclusive for diagnostic purposes.

6. *That anginas not dependent upon the Klebs-Loeffler bacillus do

*This proposition was intended to be general in its application when written, but the writer would amend it by adding: *But following all fatal anginas disinfection should be thoroughly performed.*

not require the establishment of a quarantine, or the attention of the health officer.

7. That bacteriological examinations for release from quarantine would insure better public protection against this disease, would shorten the average period of isolation, and materially lessen the expenses in a great majority of cases.

8. That while laboratory examinations do not furnish an inflexible or infallible guide to the physician, they are a great aid to him in arriving at a correct conclusion in the case; in furnishing grounds upon which to make more positive assurances to the family; in strengthening his convictions as to the best line of treatment; in showing the health officer the necessity or non-necessity for isolation; in indicating when cases may be released from quarantine, and, in fact, in placing the entire management of the disease upon a more scientific basis.

THE BACTERIOLOGY OF OUR MOST COMMON DISEASES.*

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The object of this paper is to emphasize that knowledge which is essential to a rational prophylaxis against the spread of the infectious diseases which most commonly come under our care, such, for instance, as that relating to the agents concerned in their causation; when and where such agents are to be sought for; the manner in which they are expelled from the diseased and received by the healthy body, and the steps to be taken to prevent their spread. It will be impossible in the time allowed to more than briefly go over some of the most important points in connection with these diseases. We will consider the diseases: Typhoid Fever, Scarlet Fever, Diphtheria, and Tuberculosis.

1. Typhoid Fever.

Causes.—The *Bacillus typhosus* is a short, actively motile, flagellated, non-spore-forming, non-liquefying rod, varies much in length and has rounded ends. It grows at ordinary temperature, but best in the incubator at 37° C. It is destroyed in ten minutes by a temperature of 60° C. It is not destroyed by freezing. When inoculated into animals the results are very irregular. By none of the ordinary methods of inoculation are conditions produced in animals that are in any way, either clinically or pathologically, comparable to those found in the human being suffering with typhoid fever. This disease is in all probability confined exclusively to man.

Mode of Dissemination.—The specific micro-organism causing the disease is contained in the discharges from the bowels of typhoid patients, and is generally present in the urine also, and it is manifest that all substances with which these substances come in contact may become specifically contaminated and be capable of conveying the disease. Typhoid fever is disseminated in a variety of ways, but most frequently through the water, the soil, and through green vegetables, salads, etc., that are eaten raw and that have been fertilized by human manure. It is not infrequently disseminated by milk which has become infected as a result of the use in the dairy of water polluted with typhoid evacuations. Attention has been recently directed to raw oysters as a possible dissemination of this disease. The refuse of food that has been used by typhoid patients should be looked upon with suspicion, and should under no conditions be

*Read at the School of Instruction for Health Officers and Sanitary Conference, 1902.

eaten by those in attendance. There is no evidence that the disease is disseminated through the air. Milk and other foods may be infected by insects that have been in contact with fresh typhoid stools, and thus become the means for conveyance of infection. Typhoid infection of a water supply, which is the most common channel of infection, may be direct or indirect. Direct infection occurs through the entrance of ordinary sewage containing the essential organism, or of fæces or urine discharged along the banks of a river or lake by persons suffering with or convalescent from the disease. Indirect infection occurs from discharges deposited in or upon the soil and thence washed by rain into bodies of water, or downwards into wells. Ordinary sewage pollution is not sufficient to bring about an outbreak of the disease, nor will specific pollution necessarily always be followed by the occurrence of cases. The specific organism has only a limited tenure of life and, in the absence of conditions favorable to its existence, it may perish before it reaches the consumer. Moreover the number of organisms present may be very small and the effects produced so slight as to occasion no great notice. It is to be borne in mind that not every mouthful of a polluted water supply contains the organisms, and that not every person into whose system it gains access must necessarily come down with the disease. Until quite recently it has been supposed that the infecting organisms had their origin only in the fæces of pre-existing cases, but it is now known that this is far from being the case, and that they exist in the fæcal discharge only during the early stages of the disease, or up to the twentieth day, or perhaps even somewhat later. Petruschky has shown that the urine may contain millions of living baciili in each cubic centimetre and that they may appear for many weeks and even after convalescence is well established. They may appear as early as the fifteenth day, when perhaps they are no longer demonstrable in the fæces. Dr. M. W. Richardson found them in very large numbers and in practically pure culture in the urine of nine out of thirty-eight patients. They appeared late in the course of the disease and continued to be eliminated in several of the cases after discharge from the hospital. It appears then that an apparently well person is capable of infecting a water supply to a greater extent and with less optical evidence, or none at all, by a discharge of urine into a water-course than an evidently sick one by a deposit of his fæces into it or upon its banks. Whatever the mode of infection of a public water supply, the results, if any, are seen in an increase in the number of cases ordinarily occurring in the community supplied, and, except in those instances when the disease is spread by shellfish or other foods, any considerable augmentation of cases points unmistakably to the consumption of polluted water even though the system of filtration is followed. In the latter instance, investigation will almost

always certainly show some defect in the filters, or that their capacity has been overtaxed. Even after the subsidence of the outbreak, the disease may continue to be more prevalent than usual for some little time, especially in the absence of a proper system of sewerage.

PORTAL OF INFECTION.—The disease is not contagious but infectious. It is not spread by breathing the same atmosphere with the typhoid patient. Infection occurs by way of the alimentary tract; that is, it results from actually swallowing materials that have come directly or indirectly from the bowels of an individual affected with the disease. We have no evidence that it occurs in any other way.

PROPHYLAXIS.—It is now generally recognized that the most potent factors in diminishing the widespread occurrence of this disease in communities are an unpolluted general water supply and a reliable system of sewage disposal. The conspicuous decline in the mortality from typhoid fever that has followed the adoption of such measures in many of the larger cities and towns can leave little room for doubt as to the correctness of this view. In districts where the water supplies are obtained from shallow wells there is probably no more active cause of the spread of this disease than the pollution of the soil by cesspools and privies. In such localities the soil is often saturated with the contents of privies into which not only normal intestinal contents find their way, but also the evacuations of individuals suffering from the malady. It is therefore plain that the most important domestic prophylactic measures consist in the disinfection of the bowel-discharges from all suspicious cases of intestinal trouble, and the subsequent disposal of such discharge by some method that will remove them quickly and completely from the neighborhood of human habitation. This latter is to be accomplished in cities only by means of an efficient sewage system. In the country, where sewers do not exist, reliance must be placed in the disinfection of the stools and their final disposal upon the soil. A good method of disinfecting stools and urine is to mix with each specimen double its volume of freshly prepared milk of lime, or double its volume of 1 per cent chloride of lime solution, or double its volume of 5 per cent carbolic solution, or pour upon the specimen three times its volume of boiling water. In either case cover the vessel and allow it to stand in a safe place for from one to two hours before it is emptied. This point cannot be too strenuously urged, as the stools and urine of typhoid patients are the only known source of the disease, and, as they are easily rendered inert, a good deal may be done in reducing the frequency of this disease by careful attention to this point. This disease occurs in all countries, perhaps more frequently in temperate than in countries presenting the extremes of atmospheric heat and cold. It is a disease

of late summer and early autumn, the greatest number of cases usually occurring between the latter part of July and the early part of October. Men are somewhat more frequently affected than women. It is a disease of early adult life. Though endemic in all countries, it often occurs in epidemics. A great deal of valuable information can be had by studying some of the large epidemics, as, the Lansen in Switzerland, the Plymouth, Pa., epidemic, 1885, the Philadelphia epidemic, 1898, and others.

2. Diphtheria.

Cause.—Diphtheria results from the pathogenic activity of the *Bacillus diphtheriæ*, or the Klebs-Loeffler bacillus. Diphtheria is an infectious disease which is also generally regarded as contagious. Klebs-Loeffler is a non-motile, non-liquefying, non-spore-bearing organism, and is conspicuous for the irregularity of its morphology. It grows rapidly on most of the ordinary culture media when kept at the body temperature. It is not readily destroyed by drying and when dried it has been known to retain its vitality for fourteen weeks. It is readily destroyed by both heat and chemical means. Its thermal death point at 58° C. is ten minutes. It is destroyed in cultures by the direct action of sunlight in from 35 to 40 minutes. In human diphtheria and in the experimental form, the specific organism is usually found only at the local site of disease. It is to the action of these poisons that the symptoms seen in diphtheria are due. The disease has been known since the time of Galen. It has been observed in practically all countries. The disease is more common in cold and temperate than in hot climates. It prevails much more extensively during the autumn and early winter than at other seasons. It is endemic in cities; it frequently appears in an unusually severe epidemic form in country districts. It occurs at all ages; the greatest number of cases fall between the third and the sixteenth years.

Modes of Dissemination.—Though contagious, it is nevertheless probable that the disease is never contracted by simply breathing the air of rooms occupied by diphtheritic patients, for the reason that the specific micro-organism is not contained in the breath of the patient, and is not eliminated in that way. It is, however, dislodged during coughing, sneezing, gagging, along with minute particles of false membrane from the throat. Nurses and physicians are especially liable to have bits of membrane coughed into their faces during the usual manipulations about the throat of the patient. It is accidents of this kind that make the duties of attendants on diphtheria patients particularly dangerous, and it is among such attendants that instances of direct infection occurring in this way are frequently observed. It is also to be noted that the bacillus of diph-

theria is not readily destroyed by drying, and that when dislodged from the throat in bits of false membrane it may retain its vitality for a long time. When such particles of dried membrane are disintegrated, dissemination may occur through the breathing of air laden with this infective dust. Napkins, cloths, towels, handkerchiefs, etc., etc., on which saliva from the patient has been allowed to dry, may serve in this way to spread infection. Through inattention of the hands, soiled while working about the patient, the disease may readily be spread. In short, all modes of immediate contact with the diseased person offer opportunities for infection. There is a pretty widespread belief that domestic animals are instrumental in spreading the disease. These views are probably erroneous. It must be said, however, that cats are reported to have suffered from diphtheria contracted from human beings. A number of epidemic outbreaks of the disease have been traced to the milk supply of those affected. This has given rise to the supposition that the cattle from which the milk was obtained were diphtheritic. There is no trustworthy evidence that cattle ever suffer spontaneously from a disease capable of transmitting diphtheria to man. When "milk epidemics" do occur, they are probably in all cases due to contamination of the milk with the genuine diphtheritic virus from human sources, from the family, or the dairyman, or from some of the others through whose hands it passes before reaching the consumers. There is no evidence to support the opinion that the disease is disseminated by the water. Neither is there any evidence that the disease is spread by the air of drains and sewers. Where, through defective plumbing, there is a direct passage of the infective materials thrown into closets and sinks through leaks in the soil-pipes, it is manifest that the disease may be spread by such materials finding their way into other parts of the building and not into the sewers as intended. All statistics show that those constantly engaged about sewers are not more liable to infective diseases than others.

Portals of Infection.—For faucial diphtheria the portals of infection are the nose and mouth. Diphtheric inflammations, etiologically identical with diphtheria, are occasionally observed in other localities, namely, on other exposed mucous surfaces, as conjunctiva, vagina, and upon wounds of the skin that have become infected with the specific diphtheria virus. During the course of the disease in the throat, self infection of wounds on exposed surfaces of the body are not rare. Infection of the nasal mucous membrane often results in a more or less chronic process, although the acute manifestation of the disease is likewise observed in this locality.

PROPHYLAXIS.—The most modern, and certainly the most important, prophylactic measure is that through which a condition of immunity from the disease is afforded by the subcutaneous injection of the blood-serum from an animal that has been artificially rendered highly immune from the poison of diphtheria. As the immunity thus induced is not permanent, lasting for but a few weeks at the most, this procedure is only employed when healthy persons are directly exposed to the disease, especially in the case of the well children of a family in which the disease is present. As the site of the infection is the local area of diphtheritic inflammation, it is plain that all objects in any way contaminated with matters from this area are infective and should be scalded as soon as removed from the patient. These patients should be provided with separate eating utensils, which should be scalded after each meal. The refuse from meals should be scalded with boiling water. Soiled bed and body clothing should be scalded before the secretions are permitted to dry upon them, or, when this is not practicable, the soiled areas should be moistened with 3 per cent carbolic acid, or 1 : 1,000 corrosive sublimate solution. Nurses and physicians should guard against infection by thoroughly washing and disinfecting the hands immediately after manipulating the patient. While spraying or otherwise attending to or examining the throat, a cotton mask, moistened with either of the named solutions, should be worn; this is to guard against infection that might otherwise result from bits of membrane being coughed into the mouth, nose, or face. These patients, when possible, should occupy a room in an unfrequented part of the house, and should be isolated; that is to say, only those in immediate attendance should have access to the room, and all articles that have been about the patient should be scalded or otherwise disinfected before they leave the sick room. From the standpoint of prophylaxis, it is important to note that the diphtheria bacilli do not, as a rule, disappear from the throat with the disappearance of the false membrane, but often persist far into the period of convalescence. In the experience of the laboratories of the different boards of health, it is found that the average period of persistency of diphtheria bacilli in the throats of convalescents from the disease is twenty-six days, reckoned from the date of establishment of the diagnosis by the primary bacteriological examination. In one case they were present after one hundred days, while in a few cases they have disappeared in seven days. Because of the persistence of the infective agent in the throat of these patients, convalescents from diphtheria are regarded as dangerous sources of infection until they are shown to be otherwise by bacteriological examination of the throat, and in no case should the quarantine be raised until the bacteriological report is negative.

3. Tuberculosis.

Definition and Cause.—Tuberculosis is an infectious disease caused by the *Bacillus tuberculosis,* discovered by Koch in 1882. Opinions are somewhat at variance concerning the transmissibility of tuberculosis, particularly the pulmonary form; but the bulk of evidence favors the opinion that the disease is contracted through continuous respiration of the air of apartments occupied by tuberculous individuals. Not that the consumptive throws off with the breath, in the course of ordinary respiration, the specific bacillus of the disease, for this is not the case; but rather that by inattention to the proper prophylactic measures the sputum of such patients, which contains the living tubercle bacilli, is expectorated upon the floor, into napkins, or in undesirable places, becomes dried, ground into the dust, and in this form is inhaled by those in attendance upon the patient. When infection occurs, it is probably to be explained in this manner. The bacillus of tuberculosis is a slender, rod-shaped organism, usually presenting the appearance of being somewhat beaded. It is motionless. It cannot be readily cultivated in the ordinary nutrient media, though it can be induced to grow on sterilized blood-serum, and then only at the temperature of the body. It is destroyed by the temperature of boiling water in a few minutes, and by lower temperatures also, but after a longer time. It is not destroyed by either drying or freezing. In the dry state it is much more resistant to heat than in the moist.

Geographical Distribution, Race, Sex, etc.—The disease occurs in all countries, among all peoples, and at all ages. It is more frequent in over-crowded than in sparsely settled localities, and somewhat more common in low than in high altitudes. The American Indians and the negro races exhibit a marked susceptibility to the disease, as do offspring from commingling of the white and colored races. It is seen in many of the domestic animals, notably bovines. It is quite common in pigs, rare in sheep, dogs, and cats. Many of the wild animals, in which tuberculosis does not occur while they are in their native state, develop the disease after confinement, especially the monkey and woodchuck. It is of the greatest sanitary importance to note the fact that, among the domestic animals in which the disease occurs, bovines, especially milch cows, are most often affected.

Mode of Dissemination.—The part played by heredity in disseminating this disease is most conspicuously exhibited in the perpetuation of a particular condition of vitality that renders the individual endowed with it susceptible to this form of infection. The frequency of tuberculosis in the young of tuberculous parents cannot always be referred to the

congenital existence of the disease; in fact, authorities are pretty well at one in the opinion that this is rarely the case. It is more probably due to direct infection from parent to child through their very intimate association. It cannot be denied, however, that intra-uterine tuberculosis of the fetus is occasionally encountered. Every tuberculous individual is a source from which the disease may be further disseminated. This is conspicuously true with regard to those afflicted with the pulmonary manifestations. The sputum of consumptives contains the tubercle bacillus in enormous numbers. When such sputum is allowed to dry and become ground into dust and is inhaled by those in the vicinity we see, most probably, the commonest mode of dissemination of consumption. The greater frequency of the pulmonary over the other forms of the disease speaks in support of this view. With tuberculosis of the genito-urinary tract the bacilli are found in the urine, while from intestinal tuberculosis they are thrown off with the discharges from the bowels. From skin-tuberculosis, they escape with the secretions and with particles of skin. An important factor in the dissemination of tuberculosis is its occurrence in certain domestic animals, especially those used as food. Though there is still a controversy with regard to the danger of infection from the use of flesh and milk of tuberculous animals, it should be borne in mind that the tubercle bacillus is found in both, and, so long as this is the case, these substances must be considered as possible disseminating factors, if not rendered harmless by thorough cooking. In addition there are a multitude of ways in which dissemination may occur when consumptives are closely and continuously associated with healthy individuals, as in the case of man and wife, of parent and child, of patient and nurse, etc.

Portals of Infection.—The commonest portals of infection in man are the lungs, the alimentary tract, and wounds of the skin. The disease may be produced experimentally in susceptible animals in a variety of ways. Contrary to the general rule for pathogenic bacteria, the tubercle bacillus apparently has the property of passing into a resistant condition, analogous to that of the spore-stage within the living body. When thrown off from the diseased body these resistant forms of the bacillus survive the unfavorable conditions that they encounter, such as drying, low temperature, scarcity or lack of nutritive material, and retain the power of producing tuberculosis, when conditions favorable to the exhibition of this function again present themselves. Investigations show that the tubercle bacillus, in full possession of its pathogenic powers, may often be found in the dust of rooms occupied by tuberculous patients. There is some question as to whether flesh and milk of cattle affected with the pulmonary form of tuberculosis contain the tubercle bacillus, but there is no question that, through the careless handling of such flesh and milk by butchers and

dairymen, both meat and milk may become accidentally infected, and, if used in the uncooked state, may serve as sources of infection. Tuberculosis as a result of direct inoculation, through wound of the skin, is less important to man than the preceding modes of infection. When it does occur, the process is usually localized to the site of infection.

PROPHYLAXIS.—The most important prophylactic measure is through disinfection of the sputum and other discharges from persons suffering from the disease. The patient should be impressed with the fact that he is a possible source of infection, and that it is quite within his power to control the spread of the disease from himself by attention to a few simple details that will in no way interfere with his comfort. If he is suffering from pulmonary consumption, the sputum should be spat into covered vessels containing plain water which is subsequently to be boiled. Cheap paper sputum-cups that can be burned after use are now to be had of all druggists. The cups to receive sputum, other than those of paper, should be of china or enamelled ware, and should be thoroughly scalded with boiling water at least twice daily. When the patient is away from his apartments and cannot use the sputum cup, he should be provided with cheap handkerchiefs or napkins, into which he should expectorate, which should be burned after using. A very good form of handkerchief for this purpose is the paper Japanese handkerchief. All clothing soiled with tuberculous sputum should be at once removed and scalded. The consumptive should be provided with his own eating utensils and these should be used by him alone. The refuse from his meals should be burned. The living and bed-room of the patient should be kept scrupulously clean and should be frequently aired. Under no circumstances should spitting about the room be permitted. Dusting should not be practiced, but when necessary all objects should be wiped with a cloth moistened in 1 : 1,000 corrosive sublimate solution. By thorough cooking tuberculous meat and milk are rendered free from danger. The slaughter of animals for public consumption should be under authorized inspection and control, and the entire carcasses of animals found to be tuberculous should be discarded and burned. Similarly dairy herds should be periodically inspected by qualified veterinarians and the sale of milk from all suspicious animals should be prohibited.

4. SCARLET FEVER.

DEFINITION, CAUSE, ETC.—An acute, specific fever, characterized by the occurrence of erythematous rash upon the skin, and accompanied by sore throat of varying degrees of severity. In the present state of knowledge it can only be said that the exciting cause of scarlet fever is as yet unknown, and that there have not been any suggestions upon this point

that have met with general acceptance. It is contagious, though less so than measles. It occurs both sporadically and as epidemic outbreaks. It is most common during the first ten years of life, though it is also seen in adults. It is not common in children under one year of age. It is a disease of autumn and winter and is known among peoples in all countries.

DISSEMINATION.—Scarlet fever is probably contagious at all periods, but it appears to be especially so during the stage of desquamation. The morbific agent, whatever it is, is very tenacious of life and pathogenic powers, and may cling to clothing, furniture, and the like for very long periods, retaining its power to reproduce the disease under favorable circumstances. Physicians, nurses, attendants, members of the family may carry the disease. Contagion may occur directly through the air of the sick room, and this is perhaps the commonest mode of transmission, especially when the air is laden with the fine dust-like particles of skin shed by the patient during the stage of desquamation. In the earliest stages it seems to be less contagious than later. There is no evidence that the disease is conveyed by water. There are a number of instances in which it has been carried by infected milk.

PROPHYLAXIS.—The patient should be isolated in a room as scantily and simply furnished as circumstances will permit. Because of the ease with which the disease may be carried, only the physician, nurse, or immediate attendant should have access to the room; and because of the tenacity of life possessed by the scarlatina virus, great care should be given to the disinfection of all articles before they are permitted to leave the room. The entire surface of the body of the patient should be kept oiled with some antiseptic ointment to prevent the escape of particles of skin into the air. These precautions should be observed until desquamation is complete. After removal of the patient the room should be carefully disinfected with formaldehyde gas.

5. MEASLES.

An acute febrile disorder characterized by the occurrence of coryza and an eruption upon the skin of small red papules. Measles is one of the most, if not the most, contagious of the acute exanthemata. Its cause has not yet been determined. It is a disease of the first five years of childhood, though it is also occasionally observed in adults. The rarity of measles in adults is probably to be explained through the fact that practically all children pass through the disease, and one attack usually protects against subsequent infection. It is endemic in all civilized countries and occasionally breaks out in epidemic form. It is a disease of late

autumn and early spring. It is directly communicable from the sick to the well. Vigorous efforts are rarely made to prevent the spread of measles. It is so eminently contagious that the usual efforts are considered of but little avail. The patient should be isolated and only the physician and nurse should have access to the sick room. After recovery the room and room furnishings should be thoroughly disinfected, aired, and cleaned, as after cases of scarlet fever.

SOME BACTERIOLOGICAL METHODS OF INTEREST TO BOARDS OF HEALTH.*

BY ARTHUR K. DAY, M. D., BACTERIOLOGIST STATE LABORATORY OF HYGIENE, CONCORD.

In connection with the establishment of a state laboratory of hygiene, it has seemed to me that a brief discussion of bacteriological methods, and of what may reasonably be expected of the bacteriologist, might interest a convention like the present one. I shall, therefore, try to give you a clear idea of how the work is done, and what dependence may be placed upon our results.

First, regarding diphtheria and other affections characterized by a deposit or membrane in the pharynx. For examinations in these cases, a culture upon artificial media is generally necessary before a definite opinion can be given. The culture outfit for use at the bedside is the sterile swab of cotton on a wire, inclosed in a test tube with its end plugged with cotton and covered by a rubber cap to prevent drying. This swab is rubbed thoroughly over the suspected area, returned to the test tube and sent, inclosed in its wooden case, to the laboratory by express.

I need not remind you that all disease germs are forbidden matter for the mails, so that practically the only materials that can come to us by that route are samples of blood for malaria or typhoid fever diagnosis.

When the outfit reaches the laboratory, the infected swab is rubbed thoroughly over the surface of the blood serum in the culture tube, and placed at once in the incubator, which is kept constantly at the temperature of the body. Twelve or fourteen hours at that temperature produce a good growth of the germ of diphtheria, while other germs grow more slowly. After that period, therefore, the growth, smeared upon a glass slide, dried, and properly stained, gives usually a definite picture, from which we can make our diagnosis. In 5 or 10 per cent of our cultures that are negative upon the first examination, a positive result is obtained from a second culture; so a single negative result should not influence the physician to change his diagnosis of diphtheria, when all symptoms point to the existence of the disease. The bacteriologist, with no knowledge whatever of a case clinically, should not be held responsible for the unfavorable ending, if a first examination does not reveal the bacillus of diphtheria. The laboratory of hygiene is not intended to take all responsibility from the shoulders of the attending physician, but acts as a consultant would act, in giving the benefit of bacteriological examinations.

*Read at the School of Instruction for Health Officers and Sanitary Conference, 1902.

Just a few words regarding "swab" examinations, so called; that is, immediate examinations of the material from the swabs, smeared upon a glass slide and stained, without the delay of growing upon culture media. A certain proportion of positive diagnosis can be made by this method; but the experience of the Boston city laboratory in a considerable number of examinations showed their ability to diagnose only about 60 per cent of cases that proved positive on subsequent culture. Therefore a negative result by this method is of no value whatever; and with the present arrangement at our laboratory, by which the express delivers all specimens received as late as 9 o'clock P. M., and the bacteriologist makes an evening visit at that hour, to see that all cultures are placed in the incubator, it seems to me that we get more satisfactory results.

The examinations are made by nine or ten o'clock the following morning, and can be reported by telephone or telegraph at once.

Next in frequency and quite as important are the examinations for the presence of the tubercle bacillus. The bacteriologist makes these directly from the material sent, whether sputum, urine, fæces, or other suspected matter. The germ of tuberculosis possesses the property of resisting the action of acids upon it when once it is stained by the aniline colors, and we take advantage of this property in making our diagnosis of the disease. The rods will appear perfectly distinct and brightly stained in the dried specimen, after an application of aniline dye, followed by weak acid which decolorizes everything else in the specimen. The decolorized portions take up readily a contrast stain, which renders all the more distinct the tubercle bacilli. Now in the case of microscopic examinations of sputa or other material suspected of containing the germs of tuberculosis, a negative result is to be viewed with even more skepticism than in the negative diphtheria culture, provided clinical symptoms persist and continue to arouse suspicion. Under such conditions, send repeated specimens from the same case until a succession of negatives or a positive result removes all doubt. For sending specimens in these cases the laboratory provides either the wide-mouthed glass vials, inclosed in a screw-cap wooden box, or the single wooden box coated inside with asphaltum or other impervious liquid to prevent the absorption of all moisture by the wood itself. A very small amount of sputa is sufficient,—what the patient would raise in coughing once or twice ordinarily.

For the diagnosis of typhoid fever we use the Widal test, or serum reaction, so called. This test depends upon the fact that the blood serum from a typhoid fever patient, or one who has had typhoid recently, causes a peculiar clumping of the germs of typhoid in a broth culture of the latter. This necessitates the sending to the laboratory of a few drops of blood from the patient, either dried upon a glass slide, or in the small glass tube

of our outfit for this purpose, hermetically sealed with sealing wax. The latter method supplies us with a little fluid blood serum from the patient, and is rather more satisfactory than the practice of sending a dried specimen of blood. This reaction is only demonstrable, as a rule, after the first week of the disease.

The examination of drinking water to determine the presence or absence of typhoid bacilli cannot be said to be perfectly satisfactory. True, the tests will show the germs if they are present in the specimen; but the amount examined is necessarily very small, and an undoubted source of the disease will generally fail to show a positive result. Bear in mind that a polluted stream will have two or three weeks to clear itself before the outbreak of typhoid from its pollution causes it to be suspected as the source of the disease; and the dilution of the infectious matter will be something enormous.

The recognition of the presence of the *Bacillus coli communis*, the most frequent habitant of human fæcal matter, is much more common, and is the strongest of proof of the contamination of the water by intestinal discharges.

Diagnosis of these three infectious diseases (diphtheria, tuberculosis, and typhoid) forms the great mass of the work of a bacteriological laboratory. I will only add that malaria is capable of recognition by an examination of blood smears from a suspected case, which shows the presence of the causative organism (the plasmodium) in the red blood corpuscles. The outfit supplied by the laboratory for this purpose consists of several thin glass slides, inclosed in a small tin box. This may be sent by mail.

In closing this brief paper, I have only to thank you for your attention and to invite you all most cordially to make frequent use of the laboratory, as occasion may arise in the communities which you represent.

CONSTRUCTION OF VILLAGE SEWERS.*

BY ROBERT FLETCHER, PH. D., DIRECTOR THAYER SCHOOL OF CIVIL ENGINEERING AND MEMBER N. H. STATE BOARD OF HEALTH.

A generation ago the title of this discourse would have had but a faint interest for the average New Hampshire village. Dr. William T. Smith, in a paper read here three years ago, has well stated the general situation of that period as follows:

"Twenty years ago there was no sewer or public drain in the village except in one quarter where there were two covered stone drains. Sink water or other slops were distributed over the surface or collected in cesspools. The old-fashioned back-house had no rival, and on the grounds of rich and poor bore its silent witness to the radical equality of mankind. The stone drains were ineffective and gathered filth. Of course we had typhoid fever every fall. All New England and, indeed, all the temperate zones did and still do have it. Sanitary science may eradicate it in the future; it has not yet done so."

He then showed how, in the village of Hanover, private enterprise alone took the situation in hand, and at a small cost, reckoned in hundreds of dollars only, drained and purified the soil and practically abolished typhoid fever, as to any origination in the village.

Today the increasing establishment of water supplies has compelled the construction of sewerage systems. Enlightened public sentiment and the better knowledge of sanitary laws, which our State Board of Health has done so much to promote, have almost removed the question of *necessity* of sewerage works from the region of debate.

But, unfortunately, there is not yet in some communities a sufficient appreciation of the true principles of construction of such works. It is a proverb that a man who tries to be his own lawyer has a fool for a client. As to some kinds of construction, however, too many individuals or communities think themselves quite competent to do their own engineering. Witness the money that is spent or wasted on badly designed water-works. Drain-pipe is now cheap; why cannot any level-headed man dig a ditch and lay the pipe himself, so as to carry off his house drainage, or the subsoil water from his land? The average person says to himself, "Of course I can." But he usually finds sooner or later that experience and knowledge of principles govern even in such apparently simple undertakings, and that competent advice at first, even if it costs something, is cheaper in the end. The following papers in the Reports of the New Hampshire State Board of Health are appropriate to this subject:

*Read at the School of Instruction for Health Officers and Sanitary Conference, 1902.

"Homestead and Suburban Sewerage," by J. T. Fanning, C. E., in Report for 1883 (Vol. 3).

"Sewerage of Two New Hampshire Towns" (Keene and Laconia), by George E. Waring, in Report for 1891 (Vol. 10).

"Notes on the Sewerage of Rochester, N. H.," by E. W. Bowditch, Boston, in Report for 1895 (Vol. 14).

"Sewerage in Villages," by Dr. William T. Smith, in Report for 1897 (Vol. 15), p. 193.

These show in general terms what has been done and may be done in villages or towns to get effective sewer systems. The purpose of the speaker just now is to state a few simple but indispensable principles of construction, on which there must needs be ignorance, unless one has had opportunity to arrive at an understanding of them. Half knowledge on such points mars the full success of works of this character.

1. THE PROPER SYSTEM for a village of moderate size. This should usually be the *separate* system,—taking only house drainage. Storm water must be allowed to take its natural courses or be controlled by surface gutters and drains.

2. SIZE OF PIPE.—Much misconception on this point. The speaker has known of the use of 12-inch pipe for drainage of a small group of buildings. This is truly extravagant absurdity. A 6-inch pipe (glazed earthenware) on a slope of 1 to 100, 1¼ miles long, would serve 2,500 people, allowing 50 gallons per day for each, and then fill the pipe usually only half full. An 8-inch pipe on same grade, 2 miles long, would serve 5,000 people; or on a grade of 1 to 200, and 1½ miles long, would serve 3,000 people. Too large a pipe does not work so well because the stream is always too shallow; to prevent deposits the depth of flow should be from quarter to half full at frequent intervals; this tends to keep the pipe clean. There is an example of an outlet pipe only 4 inches in diameter, laid across a low marsh with a fall of only 3 inches in 2,800 feet, and serving more than 20 houses, which has worked without stoppage for many years. At times it must work under a head of water, and of course all rubbish is excluded. However, a grade lower than 6 inches per 100 feet is not desirable, and 1 foot to 100 is ample for small pipe sewers.

3. ABSOLUTE UNIFORMITY OF GRADE is essential. The sewage must be kept moving with as nearly a uniform velocity as possible. Hence a careful survey must be made, and accurate preliminary plans, so as to establish the lines and grades for the entire system, to be operated as a whole. Independent and unrelated sewers and drains in a village are sure to cause extra trouble and expense in the end, when the inevitable time comes for providing for proper disposal at a single point if possible.

4. TIGHT JOINTS.—It is a fundamental error to lay pipe sewers with the intention of admitting ground water. The speaker knows that this has been common practice in the past, and is still being done in this state where those in charge have mistaken views on this question. Every joint should be cemented with cement mortar,—one part natural cement to one part of sand. Even so, when the utmost care is taken, joints will not be made tight under usual conditions of workmanship, and a very considerable amount of ground water will find entrance into the pipe. Open joints allow more or less sewage to escape and pollute the soil, and in times of heavy rains more or less sand and fine soil will be carried in from the soaked ditch, and sometimes, in clay soil, gradually clog or fill the pipe. The speaker has known of a cellar drain so laid which was completely choked in a few years, and of a long 8-inch pipe sewer which was so far choked as to be incapable of carying off the discharge from a small motor. Again, if trees are anywhere near the line, the roots will quickly creep after the water and, if one rootlet gets in, the entire section of pipe will soon be filled with a clump of fine roots.

5. STRAIGHT LINES AND MANHOLES.—A proper lay-out requires all parts of the system to be straight. All changes of direction should be made at manholes. Then, if by any chance stoppage occurs, it can be located from the manholes and removed through them by aid of proper tools. Lamp-holes left between manholes allow a closer location of any clog which may occur. It is true that, under certain favorable conditions of grade, curves in pipe sewers have worked well. The speaker is familiar with one system of 8-inch pipe which is without manholes and has a great deal of curvature, and yet there has been no stoppage in about twelve years. The laying, however, was constantly supervised by a civil engineer, and the grade of 1 to 100 was carefully made in favorable hard ground which could be paved with a shovel. But experience proves that such practice should not be general, especially if every house connection is not properly put in by a competent authorized person, and all rubbish excluded from the main line by proper screens and traps.

Usually the simple manholes needed are not very costly. For ordinary depths, $25 to $30 will meet all the expense of one, including $8 to $10 for a suitably designed cast-iron cover.

6. COST.—The speaker is indebted to Mr. A. A. McKenzie, superintendent of buildings and civil engineer for Dartmouth College, for cost figures relating to some recent sewer construction:

A branch line consisting of 1,519 feet of 8-inch pipe, 612 feet of 6-inch pipe, and 226 feet of 5-inch house connections,—2,357 feet in all,—cost $571, which is at the rate of 24¼ cents per foot, completed. Another line of 806 feet of 8-inch pipe and 653 feet of 6-inch pipe cost $341, or at the

rate of 23¼ cents per foot. A main line of 2,437 feet of 8-inch pipe and 969 feet of 10-inch pipe, with seven manholes from 5 to 11½ feet deep, cost $1,289, or at the rate of about 38 cents per foot. In Hanover a rental for each private connection is $6 per year. At proportional rates for large and small services the total rentals (and equivalent rentals for college buildings) amount to an income of about 10 per cent on the total cost of the entire sewerage system. There is almost no expense for maintenance or repairs. The cost of surveys, mapping, and estimates is not included in the above, but it was probably not over 4 per cent in any case. Therefore the cost need not deter any progressive community, especially as such a system is always a valuable betterment to all the property served, and the universal experience is that a good sewerage system greatly diminishes the prevalence of typhoid fever, diarrhœal diseases, and malaria.

7. FLUSHING.—Flush tanks are not usually needed excepting in a flat region where the grades are low. Generally sufficient flushing can be had by use of rain water turned in by roof leader-pipes from a few houses suitably located along the line. Some object to the offense of sewer air at the upper windows of such houses, but if there are no dormer windows, there is no danger, and no noticeable odor. In Hanover the practice has worked well, and there has been no complaint.

8. UNDERDRAINS.—In wet soil it is a common practice to lay a small tile drain, preferably alongside of the sewer pipe, at a little lower level, if practicable. It is very difficult to make the joints of such drains capable of admitting the ground water without at the same time allowing sand and dirt to enter also, and so eventually clog the drain. The so-called open joints should be wrapped with thick paper or old cloth. Excelsior not twisted or compacted is nearly useless. Then the entire joint should be surrounded with fine gravel, with a layer of sand next to that. Unless great care is taken more or less soil from the ditch will be carried off in the drain and the ditch will be giving trouble constantly by settling and causing holes or depressions in the street. In some hard soils a sewer ditch, even without an underdrain, will drain off gradually considerable subsoil water, and the adjacent soil is thus made drier.

9. DANGER OF FREEZING.—Very small indeed. Sewage, even in midwinter, usually has a temperature of 45° to 50° and that keeps all the surrounding soil warm. An exposed outlet must be protected enough to keep the frost out, so that the free outflow may not be checked. Hence three feet of cover is sufficient. But a sewer line within village limits usually has to be much deeper in order to have proper grades for house-connections. As illustrating the effective heat in sewage we may refer to the experience with the sewage filter-beds at South Framingham, Mass.

"A filter-bed with an area of seven eighths of an acre received no sewage from September until January 9. On this date there were eighteen inches of frost in the bed and ten inches of snow upon it, the thermometer reaching 6° F. below zero. On January 9, 300,000 gallons of sewage were applied to the bed, and on January 10, 150,000 gallons. It is said that the effluent appeared in the underdrain in six hours after the application of the sewage. On January 11, the frost was, in places, out of the bed for its whole depth, and on January 12 it was nearly all gone, and the sewage had disappeared from the surface. Temperature of applied sewage 50° F." The case is far different with a water-main in northern New England. The water from a pond or reservoir, from just under the ice, starts along the pipe with a temperature very near 39° F. Hence a short contact with a frosty pipe will freeze it. Therefore every water pipe and hydrant valve must be put deep enough to be out of reach of frost. The fiction that running water does not freeze has little or no bearing on this question. The water in house-service pipes may be stagnant for hours at a time; it certainly is so in hydrant connections; and the motion in a street-main is slow, excepting for short periods of time.

10. Conditions of Success.—Careful planning by a competent engineer, and incessant supervision of the construction. Conscience must be a factor in the making of every pipe joint, so that there shall be no weak spots. Any slighting or slap-dash work will make a bad job surely, and may spoil it. Then there must be foresight to construct the system so as to be adapted to proper final disposal, even if it happens that that question may be postponed for the present. But disposal is a very large problem, which we are not now considering.

These are very commonplace and simple principles, but probably not familiar to many in the audience; and, whether so or not, will bear emphasis and reiteration, because they are vital to the success of these undertakings in small (or large) communities.

A SEPTIC TANK DESIGNED FOR A SMALL VILLAGE.*

BY E. H. HUNTER, C. E., CHIEF ASSISTANT TO DARTMOUTH COLLEGE ENGINEER, HANOVER.

There is no doubt in the mind of any one, I think, that the time is not far distant when a sewage disposal plant will be a necessity in every well-regulated city and town, and will no longer be considered in the light of a luxury, as is the case to a considerable extent at the present day. Already the state legislatures are discussing, and in some cases have adopted, measures to protect the river cities and industries from the nuisance caused by the discharge of sewage into the streams. In many cities, as in the case of Albany, N. Y., the river water has become so polluted by sewage from the cities farther up the river that the water supply has been affected, and extensive filters have been installed to purify the water. This is starting at the wrong end of the problem; the sewage should be filtered or otherwise purified, and in this way leave the streams and rivers clean, ready to be used for a water supply at any point. As I said in the beginning, I think there is no question but that the general establishment of sewage disposal plants is a work laid out for the near future.

Although this is a comparatively new project, there are today a great many sewage disposal plants of various designs, most of them doing good work. It is not within the scope of this paper to enter into a lengthy discussion of the different kinds of filters and various schemes for the purification of sewage; I shall simply mention a few of the most important ones.

The most common and one of the most efficient is, perhaps, the sand filter. If land is of little value and sandy soil is near by, a sand filter can be built at very slight cost. These are being operated as continuous and intermittent filters, but have been found more efficient when working intermittently, although this generally requires the services of an attendant and considerable area.

Chemical precipitation is being used quite extensively but is found very expensive to operate. The three items of expense,—attendance, chemicals, and removal of sludge,—are all very heavy. It has been found very efficient, however, in removing obnoxious acids and other elements in the sewage from mills and other manufacturing establishments.

The so-called bacteria beds, although not so extensively used as the two forms just mentioned, have been found to produce good results. They are operated in a cycle and are very similar to the septic tank system.

The septic tank in its primitive form, the cesspool, has been used for generations, but it has remained for the science of today to discover its real

*Read at the School of Instruction and Sanitary Conference, 1902.

value. Since its installation at Exeter, Eng., for the purpose of purifying sewage, it has been almost constantly before the engineering world. It does its work in a most efficient manner and requires almost no care or attendance. Contact beds and sand filters are often operated in conjunction with the septic tank. The contact beds, which are made from coke, cinders, or gravel, are operated intermittently, as are the sand filters, but on account of the greater amount of voids will handle more sewage per square foot in a given time.

All of these systems with the exception of chemical precipitation depend entirely upon bacterial action and are in no way designed to fulfill any of the conditions of mere mechanical filtration.

For a small community the choice is of necessity reduced to one of two or three systems, and the local conditions of the individual town will further eliminate the possibilities.

The action of the septic tank and contact beds at Exeter, Eng., and the results obtained from the tank alone at Champaign, Ill., furnish ample data for designing these two systems of filtration. So satisfactory have been the results at Champaign that in a great many cases one would be justified in recommending simply the septic tank without filters. This tank at Champaign holds less than two hours' flow, but succeeds in that short time in reducing the matter in suspension 94 per cent, and accomplishes an average reduction in the organic matter in solution of 17 per cent. These results were obtained in cold weather, which makes fair the statement that this is the lowest efficiency the tank will show. The Exeter tank is filled only once in twenty-four hours and the effluent is then flowed intermittently onto coke contact beds. The results obtained as shown by analysis of the filtrates are as follows: Average diminution of dissolved oxidizable organic matter equal to 81 per cent; of free ammonia, 55 per cent; of albuminoid ammonia, 63 per cent; and practically all of the suspended matter is removed.

In designing this plant I have had these two constantly in mind and have endeavored to improve on both by combining with their best points some of the suggestions of Mr. Clark of the Massachusetts Experiment Station at Lawrence, Mass., who has made somewhat extensive experiments on this method of filtration.

THE PLANT.

The plant should be placed near the outfall of the main sewer of the town. As a basis for an estimate of the size of the tank, and also for the beds, if one decides to use the contact beds in conjunction with the tank, the water consumption of the community may be used. This will generally give a very fair estimate. A more accurate determination, and one I

should recommend, may be made by constructing a weir and automatically registering the flow by an arrangement of floats and clockwork. This register should be verified at least once a day by an ordinary measurement of the depth of the flow. The maximum flow at Hanover, as determined by the readings taken in this manner, was .25 cubic feet per second and is maintained for from six to eight hours per day. I shall take this as the basis for my design.

To prevent flooding the tank in times of heavy storms a head manhole must first be planned which will divert anything over the maximum flow directly into the river or brook. Knowing our maximum flow, the size of a weir is easily calculated which will accommodate only this flow. If on a level with the top of this weir we construct a broad flat weir leading to the overflow, then anything in excess of the dry weather flow will be taken care of.

From the head manhole the sewage is conducted down a steep pitch through a reduced pipe to the grit chambers. The reduction in the size of the pipe and the pitch deliver the sewage to the grit chambers with a great velocity, so that the grit is kept constantly stirred and the sludge prevented from stopping. These grit chambers need be only large enough to accommodate a moderate amount of sand and other foreign matter, and afford a good chance for cleaning. From the grit chamber the sewage rises into the tank proper. This is simply a covered box built entirely of cement concrete. If we are to accept the testimony of Mr. Clark, it is not necessary that the tank be covered, but in view of the fact that all the tanks from which we take our data are built in the former manner, and taking into consideration the severity of our climate, it would seem better to specify a covered tank.

The tank is divided by a partition which allows one half of the tank to be shut off and cleaned independent of the other half. The septic tank should be designed so as to be filled four to five times a day at the maximum rate of flow. This will allow from five to six hours for the anaërobic action to take place. The anaërobic bacteria reduce the greater part of the suspended organic matter and part of the matter in solution to mineral substances. What aërobic action there is takes place in the thick scum which forms on the surface of the sewage. It is to give the aërobic bacteria a chance to finish their work that the contact beds are generally added to the system. If the plant is to consist of the septic tank alone, the effluent is taken from the tank and flowed through an aërator and thence discharged into the stream. A very efficient aërator is made by flowing the effluent over a broad flat weir and then over a paddle wheel, all of this taking place under a glass roof. Churning the water up in this manner in the bright light tends to exterminate any disease germs which may have been brought from the tank.

Where the contact beds are used the effluent is led from the aërator onto large tanks filled with coke breeze or cinders, graduated in size from two inches to three inches at the bottom to the size of a walnut at the surface. There are generally five or six beds, four of which are operated at one time. By an automatic arrangement the effluent from the septic tank is first led onto bed No. 1; after this is filled the effluent shuts itself off from bed No. 1 and begins to run onto bed No. 2; when this in turn becomes filled the effluent goes onto bed No. 3 and so on around. In each bed the sewage remains until the bed next to it is filled, when the valve in the underdrain is automatically opened and the effluent passes out. Each bed in turn rests while the bed third from it is filling. The operation is continuous and without the assistance of an attendant. Allowing for a daily flow of 135,000 gallons, which is somewhat in excess of the flow we have assumed, each bed would be filled once in eight hours. This means that the cycle for each bed is two hours filling, two hours setting, two hours emptying, and two hours resting. During this time the aërobic bacteria are completing the work in the reduction of the matter in solution.

On account of the severity of the climate a cover should be specified for the filters, and a small brick house should be over the alternating gear. This latter may be kept warm by a gas jet supplied from the septic tank.

Below is appended an approximate estimate of the cost of the plant as planned:

HEAD MANHOLE.

2¾ cubic yards brick @ $10	$27.50
½ cubic yard concrete @ $6	3.00
12 feet 8 inches pipe @ $0.13	1.70
1 flapper	2.00
1 manhole cover	10.00
2 weirs @ $2	4.00
	$48.20

SEPTIC TANK.

88 cubic yards concrete (walls) @ $5	$440.00
23 cubic yards concrete (floor) @ $5.50	126.50
35 cubic yards concrete (roof) @ $5.50	192.00
Aërator	5.00
Glass roof	10.00
Wood bulkhead	5.00
2 4-inch gate valves @ $10	20.00
2 3-inch gate valves @ $5	10.00
2 2-inch gate valves @ $2	4.00
70 feet 10-inch pipe @ $0.22	15.40
150 feet 4-inch pipe @ $0.06	9.00
5 manhole covers @ $10	50.00
500 cubic yards excavation @ $0.15	75.00
	$961.90

FILTERS.

88 cubic yards concrete (walls) @ $5	$440.00
43 cubic yards concrete (floor) @ $5.50	236.50
70 cubic yards concrete (roof) @ $5.50	385.00
5 cubic yards brick @ $10	50.00
4 cubic yards brick (gear house) @ $10	40.00
Roof (gear house)	20.00
175 feet 10-inch split pipe @ $0.22	38.50
30 feet 10-inch pipe @ $0.22	6.60
150 feet 8-inch pipe @ $0.15	22.50
105 feet 6-inch pipe @ $0.09	9.45
300 feet 4-inch pipe @ $0.06	18.00
5 tanks @ $5	25.00
10 valves @ $5	50.00
200 feet chain @ $0.05	10.00
5 manhole covers @ $10	50.00
1,250 cubic yards excavation @ $0.10	125.00
105 tons coke @ $4	420.00
Cinders	30.00
	$1,976.55

SUMMARY.

Head manhole	$48.20
Septic tank	961.90
Filters	1,976.55
	$2,986.65
Add 10 per cent	298.66
	$3,285.31

NOTE.—All concrete to be made in the proportions of 6-3-1.

This is, in brief, a description of a sewage purification plant such as almost any small town could adopt. It is simple in construction, may be built at a small cost, requires but little expense for maintenance, and is very efficient. While I should recommend the use of the contact beds in connection with the septic tank wherever practicable, still, as some one has said, it is very probable that the effluent from the septic tank is as free from organisms as many of the streams into which we are now discharging our sewers. When such a satisfactory remedy as this is at hand there is but little excuse for the continued pollution of our streams and rivers.

THE STRUGGLE AGAINST CONSUMPTION.*

BY EDWARD O. OTIS, M. D., BOSTON.

More than seventy-five years ago one of the most eminent physicians of his time, the celebrated Louis of France, wrote the following words: "Phthisis (consumption) almost invariably terminates fatally after a space varying between a few weeks and several years." Sixty-four years later another eminent physician of France, Professor Bouchard of Paris, concluded a lecture as follows: "This disease (consumption), which has such a strong hold on humanity, is curable in the larger number of cases." Which of these contradictory statements is correct? Let us refer to some recent clinical results for the answer.

The two most prominent sanatoria for the treatment of pulmonary tuberculosis in this country are those at Rutland, Mass., and Saranac in the Adirondacks. In the fifth annual report of the sanatorium at Rutland, for the year ending September 30, 1901, Dr. Clapp, one of the visiting physicians, reports 67 per cent of the incipient cases as apparently cured or arrested, and of all cases in all stages of the disease 50 per cent as apparently cured or arrested. Dr. Bowditch, the other visiting physician at the same institution, reports 79 per cent of the purely incipient cases as arrested, and of all cases in all stages 42.23 per cent as arrested, and by "arrested" he means, as he says, cases in which cough, expectoration, bacilli, and fever have disappeared, and where the appearance and general condition have been those of health. The term "cured," or "apparently cured," he does not use until, after the lapse of one or two years, the patient shows no symptoms of relapse.

In the seventeenth annual report of the Adirondack Cottage Sanatorium at Saranac, for the year ending November, 1901, Dr. Trudeau, the physician in charge, reports that of 173 patients discharged during the year, in various stages of the disease, forty-five were apparently cured and in seventy-nine the disease was arrested. "Some sanatoria," says Knopf, "claim as many as 70 per cent of cures where the patients are admitted to treatment in the incipient stages, and I have reason to believe," he continues, "that these figures are exact, for pulmonary tuberculosis in the earlier stages is, indeed, one of the most curable of all chronic diseases."

The evidence is overwhelming that consumption is abundantly curable, both with and without treatment, for autopsies made upon individuals dying of other diseases frequently show cured foci of tuberculosis. "As for my personal experience at the morgue in Paris," said Professor Brouar-

* Read at Concord, N. H., April 29, 1902, before the New Hampshire Association of Boards of Health.

del at the British Congress on Tuberculosis last summer, "where I frequently made *post-mortems* on accidental deaths, I can state that in half the cases, if the person on whom the *post-mortem* is made has lived in Paris for about ten years, I find healed tuberculous lesions. Phthisis is, therefore, curable, he concludes, even in its most advanced stages.

At this same congress Professor Koch remarked in his memorable address that it must be regarded as an undisputed fact that tuberculosis is curable in its early stages. Those of us who have had much to do with this disease can corroborate these statements from our personal experience, although of course the earlier the case of consumption comes under treatment the better the chances for recovery, yet the disease can be arrested in all stages.

"I suppose you receive only the incipient cases," I remarked last summer to Dr. Walther, who is the physician in charge of Nordrach, one of the most famous sanatoria in Europe. "I take any case that comes," he replied, "for I cannot tell what case will and what will not recover." At the present time I have under observation a young girl who had disease of both lungs with cavity in one, and when she first applied at my clinic she manifested all the symptoms of advanced disease. Now, after a year or two of the open-air treatment, she looks the very picture of robust health, and is able to support herself by working.

Consumption, then, is curable. There is no shadow of doubt regarding this fact. The question immediately arises as to the treatment. How is consumption cured? Not by drugs, but by what is known as the hygienic, dietetic treatment, which in brief consists in constant exposure to pure fresh air day and night; abundant and proper food; scrupulous avoidance of over-fatigue either mental or physical, and, in brief, such care of the body as will strengthen, harden, and finally render it an unsuitable soil for the tubercle bacillus. Sometimes complete rest for days or weeks is imperative in the course of treatment. Sometimes moderate exercise is allowable. This treatment seems easy in the telling, but it requires strenuous exertion to carry it out, and for many natures it is almost an impossibility outside of a sanatorium. One has to be trained to it, and kept up to it by constant, continuous, firm supervision. I am sometimes almost inclined to think that, after all, the greatest value of the sanatorium is in this training, and I quite agree with Anders, who says "the principal advantages offered (in the sanatorium) are due to a rigid system of hygiene under the close supervision of competent medical officers."

With the poor it is well-nigh impossible to carry out this treatment at home; hence the incalculable value of state sanatoria for this class, and the obligation of the state to furnish such provision. Many states in this country are now recognizing this duty, I am glad to say. No other

treatment or attempted treatment has stood the test of time but this, the open-air treatment, as best exemplified in the sanatorium. It has produced and is producing the most favorable results, unapproachable by those of any other method.

This established fact of the curability of consumption and its easy and great curability in the early or incipient stage, and the only successful method of cure, the open-air treatment, cannot be too strongly impressed upon the medical profession and the public. The former, the physicians, must discover the disease early, for that is the golden opportunity for treatment. As Prof. Clifford Albutt well says, "There has been much supineness in the matter of early diagnosis and supineness bred of pessimism, of despair. Let us bring the inspiring message of optimism, of enthusiasm, and let every physician, however modest his sphere, remember that upon his alertness depend the life of the sick man and the stamping out of infection. The incipient case of today is the advanced case of tomorrow. Never let muscular strength, red cheeks, or a well-formed chest blind us to canker within" (Address delivered at the British Congress on Tuberculosis).

In the writer's judgment, every person who consults his physician, complaining of being run down, of loss of strength, shortness of breath,—whether or not he has a cough,—should receive a very careful examination of the lungs. On the other hand, the people should likewise seek medical advice when they feel conscious of loss of strength, weight, and appetite, or begin to be a little short of breath. When the diagnosis of pulmonary tuberculosis is once made, the patient should be frankly told the nature of his disease, and the vital importance of immediate recourse to the open-air treatment with all that that implies should be impressed upon him. He should be made to understand that only by strenuous, persistent, patient effort can he recover, and that medicine is of very secondary importance. He should also be carefully instructed as to the means of avoiding infecting others.

But prevention is better than recovery, even if the latter were assured in every case, and prevention is possible, because we now know the true nature of the disease. We know that it is caused by a parasite, the tubercle bacillus, and hence is infectious, contagious, or communicable. We know that the channels by which this infection is conveyed are accessible and controllable, and that they are chiefly the dried sputum of a patient suffering from the disease. "This parasite," says its renowned discoverer, "is a visible, palpable enemy which we can pursue and annihilate, just as we can pursue and annihilate other parasitic enemies of mankind." If it were practicable to isolate every patient at the present time afflicted with pulmonary tuberculosis the disease in a comparatively

short period of time would be stamped out as completely as leprosy was in central Europe in the Middle Ages, through isolation in leper houses. Of course isolation in every case is impracticable and we must, therefore, proceed on less drastic and slower means. We must, so far as possible, control the tuberculous sputum, and at the same time do what we can to render the human soil unsuitable for the growth of the tubercle bacillus. This latter is accomplished by whatever means tend towards the improvement of the health of the people: better sanitation, public and private; improved housing; better preparation of food; more fresh air in living and sleeping rooms.

In a recent conversation with one of the commissioners of Minnesota, who were investigating the subject of state sanatoria, he told me that consumption was most prevalent in his state (Minnesota), not in the crowded portions of the cities, as is most frequently the case, but among the Scandinavian farmers in the country districts, and the cause assigned—which I doubt not was the correct one—was that during the cold winters the farmer shut up his house tight and breathed and rebreathed the same impure air. May not this state of things be a common one among the New Hampshire farmers? Further, sufficient rest after labor, personal care and cleanliness, and the education of the individual in habits of wholesome personal hygiene are all important. In brief, all sanitary measures which will render our houses, streets, towns, and ourselves clean and healthy tend towards rendering the individual sterile to the tubercle bacillus.

To control the tuberculous sputum, we must, as far as possible, have knowledge of the existing cases of consumption; hence the reason for compulsory notification. The people must be instructed as to the dangers of promiscuous spitting. As you are aware, laws against this habit now exist in many places. We must instruct the tuberculous and their families and friends how safely to dispose of the sputum, and that whenever the patient arrives at the stage of softening and is confined to his bed, he should be placed in a room by himself, for there is always the possibility of infection when others occupy the room with him. Again, the room which has been occupied by a tuberculous person should be sufficiently cleaned and disinfected.

Sanatoria should be provided at the expense of the state or community for the poor consumptive who is in the curable stage of the disease, and means of isolation in a consumptive hospital or other institution for the advanced hopeless cases who, from ignorance, helplessness, or willfulness, cannot or do not safely dispose of their infectious sputum. Further, the question of permitting a tuberculous individual, with tubercle bacilli in his expectoration, to pursue his occupation where infection to others is

possible through the so-called drop infection from cough or carelessness in care of the sputum, is one of serious consideration. A cook, waiter, janitor, clerk, house servant, teacher, pupil, baker, or one who handles food of any kind, may be the medium of spreading tuberculosis, if he is in the infectious stage, and evidence is not wanting to prove this. If such persons are removed from their occupation for the public protection, should not the public in turn afford them suitable treatment as well as isolation in a sanatorium, and in addition some support to their families bereft of the wage-earner?

All this seems a colossal undertaking, but the example of other states and countries teaches that it can be done, and the loss and suffering entailed by this most prevalent and destructive disease warrant, nay, demand the effort. The public or state sanatorium subserves three most important purposes:

First. It affords the best means of cure.

Second. It isolates the consumptive.

Third. It sends forth teachers, in its cured patients, of wholesome hygienic living and of the avoidance of danger from the sputum.

Since the discovery that pulmonary tuberculosis is communicable an obligation is put upon the state to protect itself, as in the case of other contagious diseases, and in doing so to afford the unfortunate victim of the disease an opportunity of recovery when private means are wanting for this purpose. It is, moreover, an economic measure, for consumption is most prevalent at the most efficient working period of a man's life, and the value of the labor of those saved by sanatorium treatment will, in the long run, more than compensate for the outlay in the construction and maintenance of the sanatorium.

The insurance societies of Germany which insure against sickness and old age are finding it more economical to send their consumptives to a sanatorium and have them again returned to their work with their disease cured or arrested than to pay them insurance through the long disablement caused by the progressing disease. The statistics of the German Imperial Board of Insurance show that in 1897 and 1898, 8,200 insured men and women were treated, and of these 5,848, or 71 per cent, left the sanatoria fit for work (Hillier, "International Aspect of the Control of Tuberculosis," read at the British Congress on Tuberculosis).

Since the people of Massachusetts have observed the marvelous results of the sanatorium treatment at Rutland, and the instruction spread broadcast over the state as to the avoidance of the disease, through those treated and cured at the sanatorium, they not only willingly and eagerly tax themselves for the continued maintenance of this institution, but there is at the present time a bill before the legislature of that state for an

appropriation for a second similar institution. Almost every country now recognizes the value of the sanatorium. Germany at the present time has sixty-eight sanatoria for its poor consumptives and nineteen for paying ones, affording accommodation in the course of a year for twenty thousand patients. England has many free and paying consumptive hospitals and sanatoria. Recently Sir Ernest Cassel placed at the disposal of the king $1,000,000 which his majesty proposes to devote to the establishment of sanatoria, in view of the enormous prevalence of tuberculosis. Russia, France, Austria, Belgium, Norway, Holland, Italy, Canada, Spain, Cuba, and others either have sanatoria already established or in construction or contemplation. In this country every New England state and many of the middle and western ones have now bills before their legislatures either for an appropriation for a sanatorium or the appointment of a commission to consider the matter. In a comparatively few years I feel certain that at least the majority of the states will have one or more sanatoria, and thus we shall see the whole civilized world successfully and humanely treating their consumptives, and in just so far protecting themselves.

In the Middle Ages who ever thought that leprosy, then well-nigh universal over western Europe, would ever be exterminated? But leper houses accomplished it. I do not mean, however, to say that sanatoria alone will exterminate consumption, though they will greatly aid in so doing. We must also labor, as I have indicated, in the way of general prophylaxis. Educate the public as to the danger of infection. Teach them that in the consumptive, and in him alone, resides all the danger, and that when he expectorates or coughs out tubercle bacilli in his sputum where it can become dried, then the army of infecting micro-organisms is on its march of death and destruction, for it has been estimated that a consumptive emits daily 800,000,000 tubercle bacilli. We must labor to disabuse the public of their old erroneous ideas of consumption regarding its incurability and inheritance. It is most difficult to eradicate this settled conviction of inheritance, and most people, I suspect, still believe it. It was a very natural conclusion to draw when one saw member after member of the same family succumb to the disease. "Now, however," says Koch, "it has been demonstrated by thorough investigation that though hereditary tuberculosis is not absolutely non-existent, it is, nevertheless, extremely rare, and we are at liberty, in considering our practical measures, to leave this form of origination entirely out of account."

Associations for the prevention of tuberculosis now exist in almost every civilized country, whose object is to disseminate information regarding tuberculosis; to educate public opinion; to aid state and local boards of health, and to initiate efforts in various ways towards prevention. An

immense amount of good work has already been accomplished by these means. I have only to refer, as an example of this kind of effort, to the great National Association for the prevention of tuberculosis of England, with its local branches, which culminated in the Congress on Tuberculosis, held in London last summer. How much can be accomplished by these various methods of prevention is shown by the decrease of mortality from tuberculosis in Prussia in the years 1889 to 1897, as quoted by Koch in his address before referred to. Before 1889 the average mortality was 31.4 per 10,000, while from 1889 to 1897 it was only 21.8 per 10,000, which meant that in that space of time the number of deaths from tuberculosis were 184,000 less than was to be expected from the average of the preceding years. Again, in New York the mortality from tuberculosis has diminished more than 35 per cent since 1886. In all I have said I have taken it for granted that we all realize the enormous prevalence of tuberculosis, and that it is a universal plague, annually destroying 3,000,000 in the whole world and infecting yearly about 15,000,000, an appalling number, indeed. But our hope in the struggle is founded upon four great facts:

First. That pulmonary tuberculosis is contagious and not inherited.

Second. That it is avoidable.

Third. That it is curable.

Fourth. That the sputum of the consumptive is the main source of infection and that this is accessible and can be controlled.

I close with the words of a recent writer, himself a victim of tuberculosis and cured by the sanatorium treatment at Nordrach: "When every consumptive who needs it will receive sanatorium treatment at the general expense, and be insured, where necessary, suitable work and life conditions thereafter, then will the days of this scourge be numbered. Then will man no longer be called upon in the bloom of his manhood to face, with his mental faculties unimpaired, a death by inches. Then will break the dawn for a healthier and happier people" (James Arthur Gibson, "Westminster Review," April, 1902).

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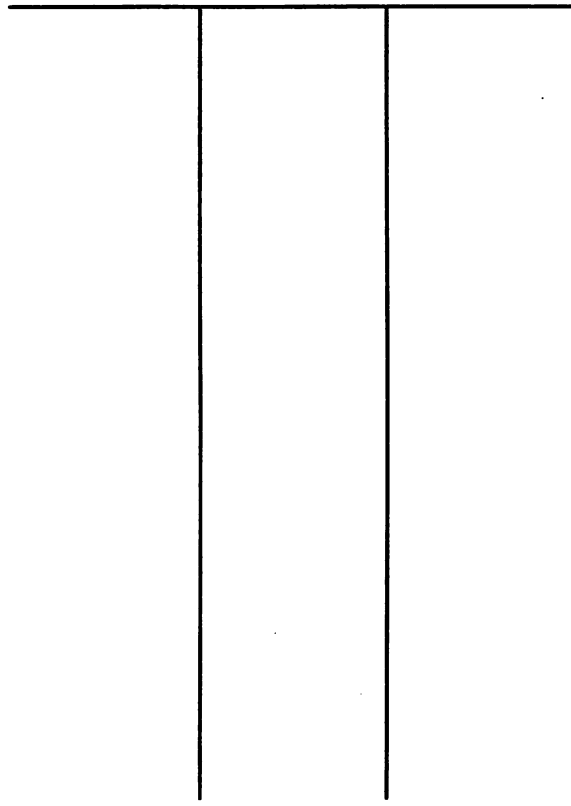

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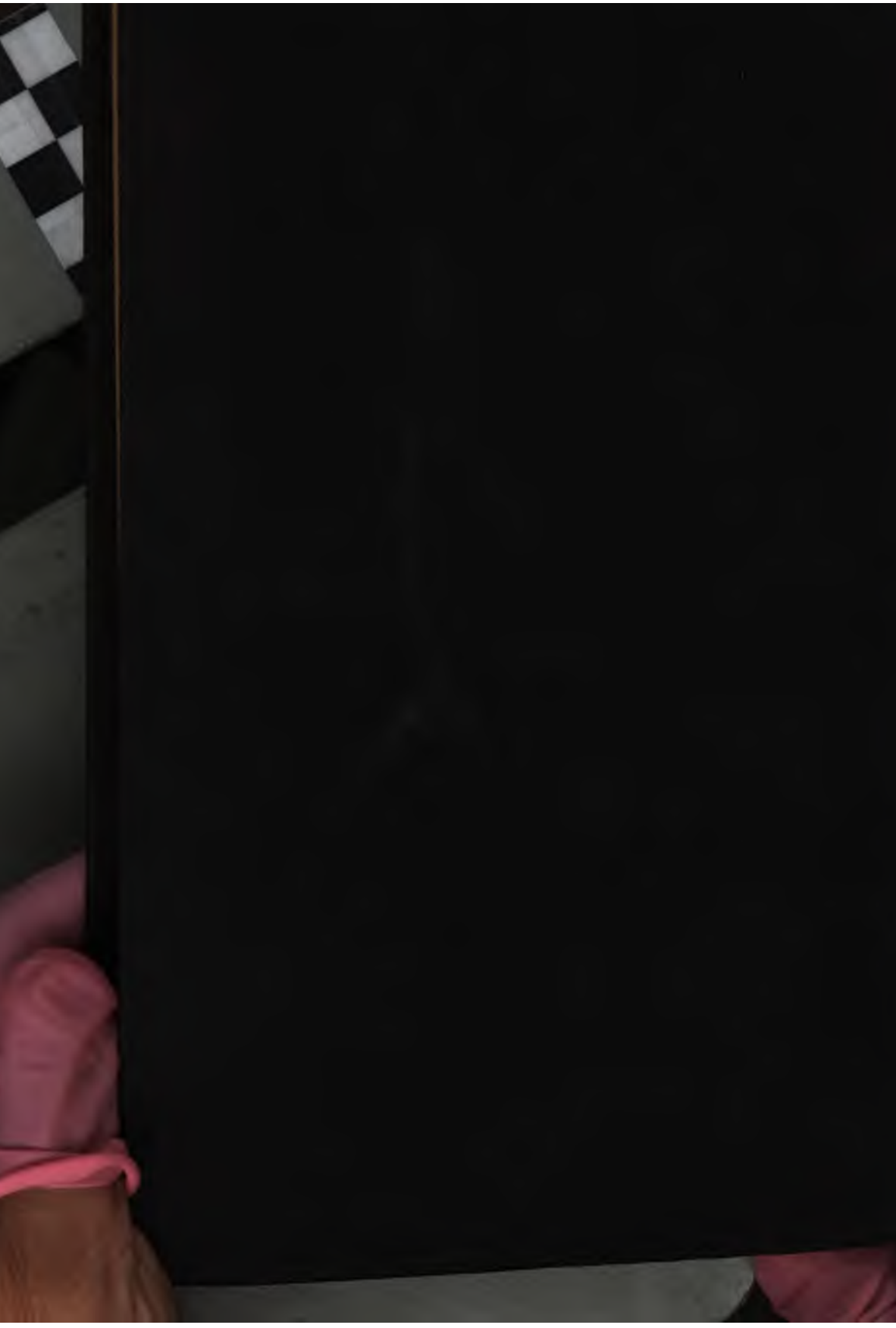
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